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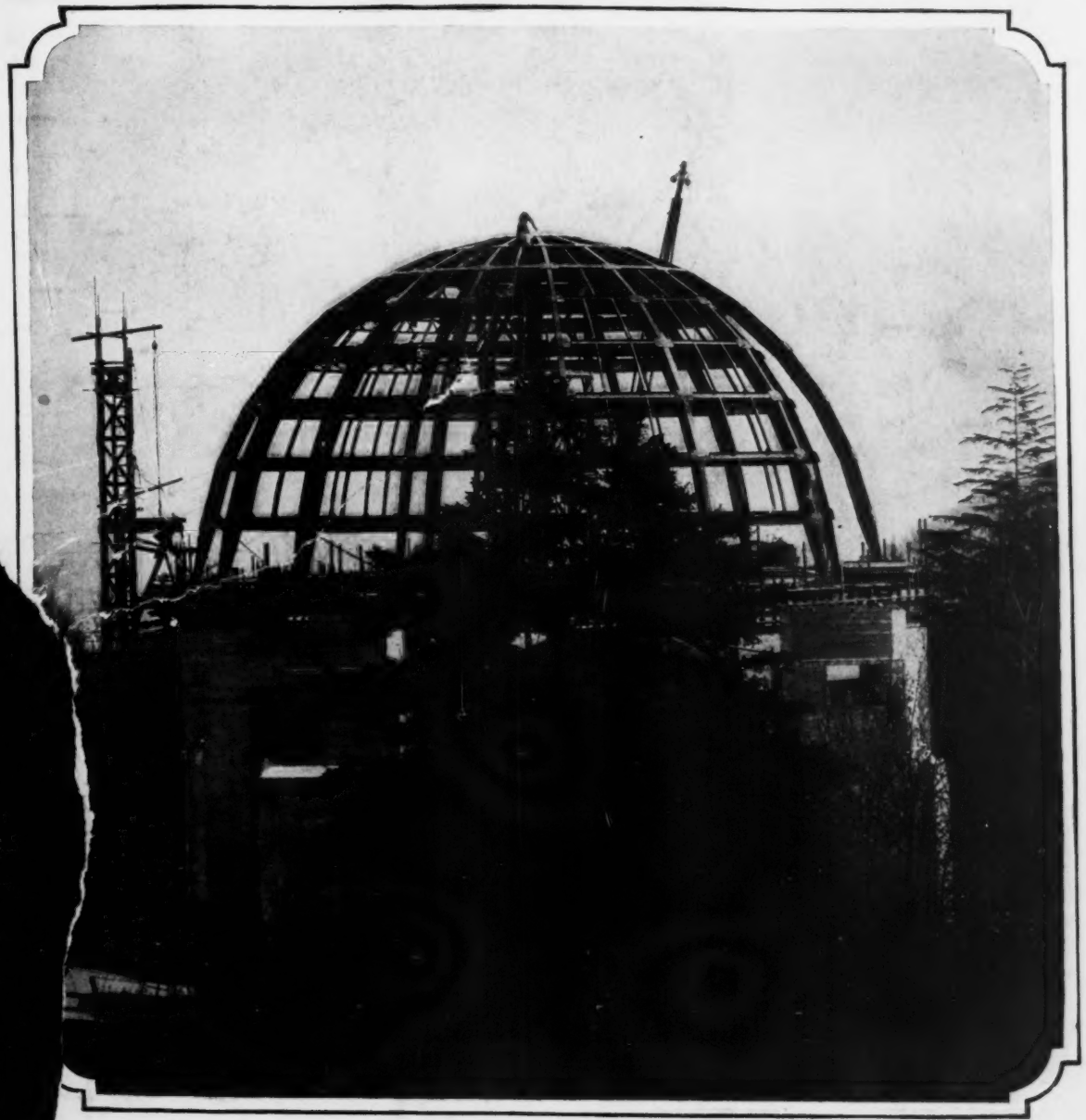

STEEL-FRAMED DOME ON PORTLAND CATHEDRAL

Structural Details of a Hemispherical Steel-Framed Dome, by Henry F. Blood

State Highway Ferry Service at the Straits of Mackinac, by M. de Glopper

Plastic Flow and the Strength of Cold-Worked Steel, by Earle B. Norris

Monthly Prices of Construction Materials and Current Index Figures of Construction Cost and Volume

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

McGraw-Hill Publishing Co., Inc.
JAMES H. MCGRAW, *President*
E. J. MEHREN, *Vice-President*

Volume 99 NEW YORK, OCTOBER 6, 1927 Number 14

Tornado Ruin Again

ST. LOUIS' disastrous storm visitation comes almost exactly a year after the unparalleled devastation of southern Florida. Again there are a hundred deaths to be reported, and many tens of millions of property losses. The tornados that come out of the cyclone-cellar regions of the Great Plains are more intensely destructive than the Caribbean hurricanes, though their narrow paths seldom cross a populous region. Unfortunately that rare event came to pass last week, and a swath of ruins was cut for miles through the city's residential district. The disaster was almost a precise repetition of that which the city suffered thirty-one years ago. It seems that the earlier visitation remained without influence on building practice. Today we have come to be more keenly conscious of the need of profiting by the severe lessons of Nature, and there is hope that sufficiently close study will be made of the storm action and of building resistance to bring about a thorough understanding of what preventive measures it is feasible to take against future tornado violence. From the great Illinois tornado of two years ago we learned, through surveys made by parties of state and college engineers, that more resistant construction is feasible, without excessive cost. The present disaster may teach more definitely what should and what can be done at reasonable expenditure as insurance against such extremely rare hazard. We believe that the responsibility for this study will be realized by the engineers and architects of St. Louis. But invaluable aid could be given, we think, by co-operation on the part of the federal Department of Commerce, whose building code committee is competent to interpret the results broadly and disseminate the conclusions all over the country. The preliminary facts reported by Mr. Knight on another page point to a close analogy between the destructive effects at St. Louis and those observed last year at Miami, in spite of the different character of the two storms. In both instances, needless weak spots in construction were large factors in the damage done. If these weaknesses could be eliminated or reduced by co-operation of local and federal work, the entire country would gain.

A Worthy Budget Item

AMONG the many items being pressed upon the director of the budget for inclusion in the next Congressional Appropriation bill is one of $100,000 for an investigation of the causes underlying the unprofitable operation of a large percentage of the manufacturing concerns of the country. The proposal is to have the Department of Commerce conduct the investigation. Presumably it would include, among other things, a study of a number of engineering factors, such as efficiency of machines, methods, labor and administration, and also depreciation, particularly depreciation in one of its most evil forms, obsolescence. The investigation is a worthy one. It is to be hoped that Budget Director Lord will insert the item in the budget, the President sanction it and Congress make the money available.

By Force Account

RAILROADS naturally are inclined to do work by force account. They must keep, of necessity, a few trained construction men on their rolls for emergency work, and consequently favor using them as the nucleus of construction organizations when special work of not too great magnitude is to be undertaken. Some such consideration may have inspired undertaking so large a piece of construction as building with company forces the substructure of the Atchafalaya River Bridge of the Louisiana Ry. & Navigation Co., described elsewhere in this issue. It may be that the railroad's engineers did not believe that there was a contractor of sufficient experience or possessing the proper equipment available in the region. But in view of the ease with which an experienced contractor moves a large plant even to relatively out-of-the-way places it hardly seems as if the company was justified in making so large an investment in construction plant as was called for by this work without making sure that no contractor would undertake the work at a reasonable figure.

City Toll Bridges

A NEW and strange note is sounded by some residents of New York who propose to build a toll bridge across the East River. The structure would be within the city and carry essentially intra-city traffic. It is badly needed, but it would cost many millions to build and the city has other use for all the money it can spare within its legal borrowing limit; this is the reason for proposing to build the bridge with private money and charge toll for its use. The project is the first in many decades—in modern times, it may fairly be said—which suggests erecting a toll barrier to free traffic movement within a city. It is a matter that invites serious thought. Municipal conditions are undergoing many and rapid transformations, and the doctrine of one generation does not necessarily apply in another. Municipal financing today is a complex and difficult matter, made so by the alarming growth of public needs and the restriction of city debt limits. The latter, set up in earlier generations, are in part frankly anachronistic; yet debt limits there must be, if public credit and financing soundness are to be maintained. When municipal financing reaches its limit, obviously we must call in private financing for aid. Thus there are substantial reasons for toll bridge construction. They are, in fact, closely similar to the reasons that support toll bridge construction outside of cities. *Engineering News-Record* was first in advocating such

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construction, under proper conditions for public protection. Intra-city toll bridge construction, however, is of another color, we think. To permit the erection of even light barriers to free street transportation within a single municipal unit appears questionable policy.

Growing Capital

IT APPEARS from the most recent statistics that whether business and industrial conditions hold firm or vary, whether they are doubtful or promising, construction work maintains itself at a high rate of activity. Moreover, it is growing in a remarkable way. For more than a decade the annual totals of building and engineering construction have trended upward, with the net effect that during the 14 years since 1913 the rate of investment in new construction has been multiplied nearly six-fold in dollars or three-fold in brick and steel—though the population of the country has grown only 15 or 20 per cent in this period. The nation's plant investment, its productive capital, thus is growing rapidly. The fact reflects the truth that construction is the natural outlet for accumulated public wealth, and that wealth is bound to flow into permanent construction so long as production continues at a normal output rate. But the steadily maintained building activity has a much more important relation to our well-being. Construction operates as an important balance wheel between prices and cost. It represents a market reservoir on the one hand, and a steadying agency on rentals and fixed charges, that tends to oppose fluctuations of industrial conditions. This governor action is of great value. No serious instability of our industrial organism need be feared so long as construction on a sound financial basis is maintained at the present rate.

Safety Improvements

A REMARKABLE total of work is in progress throughout the country in the detail improvement of roads and streets to facilitate traffic. Widening and rounding of corners is one of the most extensive items in this field. There are probably few cities that are not now engaged in doing some work of the kind. The motive for most of it is the need for facilitating traffic and increasing capacity. It has a direct relation to safety, however. The discussions in the meetings of the National Safety Council last week gave recognition to this relation, and stressed the desirability of encouraging the work. It is axiomatic that whatever makes traffic easier and smoother will also make it safer. Whether the improvement work is undertaken to relieve congestion or to remove danger spots, it addresses itself to the same object, namely that of making the highways more efficient. And the fact is that after all possible blame for traffic casualties is placed on the road user, there is a large share of blame resting on the highway itself. Improvement work, therefore, should and will continue at increasing rate. Since it presents one of the most perplexing details of modern public works engineering, *Engineering News-Record* plans to give the subject special attention in the early future, by placing on record in some detail what is being done in this field and showing by example what can be done. The great sums of money now being devoted to this work will be applied most effectively if they are guided by experience.

An Acute Problem

THAT the present-day city engineer faces a new and decidedly acute problem was brought out forcibly at a meeting of New York State city engineers last week. The problem is that of building up and maintaining a public-works engineering staff competent to deal with the multiplied service demanded by modern conditions. It is the problem that is present also in the large city, and is there beginning to find recognition by political leaders, as mentioned in these columns last week.

Last Friday there gathered at Binghamton some 75 engineers representing the municipal engineering fabric of New York State. The reason for their meeting was to formulate and adopt a constitution and bylaws and establish an organization to be known as the Association of City Engineers of New York State, which would have as a principal aim the fostering of "mutual welfare." Such organizations are not new in the engineering field, for the engineer, dealing as he does with theory or fact and figure, has need for the association of his fellows to keep up his own social morale. But they frequently have failed to thrive, partly because engineers are often too tight-lipped, at least in open session. The Binghamton meeting was distinguished by a more pressing purpose than mere social contact, for it was occupied almost wholly with the urgent question of how to keep up efficient staffs in the city engineering departments—how the citizen, in other words, is to be given the thorough and competent engineering service which he should have.

In the past, at such meetings as that held at Binghamton, increased compensation for the individual has been stressed when "mutual welfare" has been the end sought. Here, however, a broader phase of the subject occupied the engineer's attention—the need for recognition of the value of the whole municipal engineering organization as the precedent to more economical engineering servicing. Emphasis was placed upon the fact that both the general public and the political administrators of each city should know what its engineering staffs are doing, what educational and experiential preparation lies behind fitness for the positions held, and what a reasonable compensation should be for the respective grades. Lack of that knowledge has aggravated conditions in the city or village until they have become wellnigh intolerable. Increased needs of traffic, grade crossing elimination problems and the provision of recreation facilities have latterly imposed upon the city engineer and his organization new duties for which there has been no commensurate appropriation increase to care for engineering supervision. One city engineer with a large organization reports a labor turnover of more than 30 per cent. Another finds his best designer employed by the successful contractor for building the water-works installation he had just designed. Insufficient funds, a third states, necessitated the employment of an untrained man, and the work he superintended had to be rebuilt, with heavy cost to the city.

Such conditions as these are palpably uneconomical. Competent engineering supervision can be secured, but the taxpayers must pay the cost, and they must be educated to the economy of paying first for competence. No industrial firm, organized for and making a profit, can afford to pay the cost of excessive labor turnover. No more can a city pay the cost of running a training school for young engineers and be assured that economy and competency underwrite its engineering services.

What, then, can be done? What can this body of men, representing the engineering supervision of the largest urban population of any state in the Union, accomplish to this desired end? The individual engineer, himself, should learn to be an articulate being, for he is largely responsible for the conditions he now must endure. He can gain recognition for his work and his organization by telling the public through newspapers and other journals the more popular phases of his work. He can write his annual reports in such a photographic manner that they will contain data which every taxpayer can understand. He can talk to business organizations at their luncheon meetings. These activities are not political gestures, but should be considered part of the duties of any public officer engaged in the improvement of the condition of the human animal. With these conditions the rule instead of the exception, the city engineer will be able to build up and hold an efficient organization, and the engineer himself can doff the Stetson, woolen shirt, corduroys, and high-laced boots with which the public has erroneously clothed him, and don the more serious, though perhaps the less glamorous, garb of the man of affairs.

Pooling Railroad Incomes

POOLING incomes has been proposed as a method of solving the financial difficulties of some Western railroads in this country and a provision approximating the results of pooling was written into the Transportation Act when the railroads were turned back to their owners after the war, but neither has been tried out. In France, where the railroads are much more closely related to the government through state ownership of some and provisions for guaranteeing the income and subsequent recapture of the others, pooling of incomes was undertaken in 1921 as a means of relieving the government from having to meet all of the deficit of the lines which were operating at a loss. In the pooling arrangement the excess income of each of the more prosperous railway systems, after operating costs and interest charges on both capital shares and bonds equivalent to the guaranteed amounts had been paid, also after the deduction of certain premiums to roads whose operating efficiency exceeded a specified amount, was to be placed in a common fund from which roads having deficits were to recoup their losses, the government paying the balance if the fund was insufficient. Rates were to be fixed by the railroads themselves subject to approval by the government. There have been several increases.

The plan has been in effect for over five years. Last year, for the first time, the excess income of the three privately owned railroads more than offset the deficits of those owned by the state and a balance of 555,000,000 francs was left in the common fund to help repay the government for meeting past deficits.

At this distance it is difficult to measure the value of this plan as an aid to carrying the French railroads through a period of financial distress, but there is one feature of it which is worthy of note. The plan, a very radical one in its effect upon the privately owned railroads, was put into effect in a comparatively short time after it was proposed and has been permitted to function without such protracted legal battles as have so far nullified the recapture provisions of our own Transportation Act. Possibly this was accomplished through the better understanding which exists between the French government and the railroads. The pressure of the financial emergency of course was an important factor. Or, possibly, it may be that the owners of the private railroads, knowing that their property eventually would pass to the government, were less inclined to fight for what they consider their rights than are the owners of railroads in this country.

The Axe Falls in Baltimore

CONSIDERATIONS of efficiency and the rights of faithful public servants were thrown to the winds in Baltimore last week when the mayor nominated—and the city council hastily approved—a number of new department and bureau chiefs to take office Oct. 3, the first date upon which the new administration could make changes in the appointive positions under its control. The worst slaughter occurred in the Department of Public Works, where the chief engineer and most of the engineering heads of bureaus under him, engineers of prominence having long records of service with the city, were replaced for no apparent reason other than that they were not of the mayor's political party.

Recently, Baltimore reorganized its city government, concentrating most of its engineering activities in the Department of Public Works under a chief engineer as head of the department and having bureaus for the various functions, such as water supply and sewerage, each headed by a bureau chief with the education or experience noted in our news section. There have been few changes in the Department of Public Works in the past four years, no radical changes in many years. The engineering department of the city has been singularly free of political interference and as a consequence the city has been fortunate in having the services of some engineers well known in the municipal engineering field, men who have served with equal satisfaction under both political parties. One of them, Major Shirley, has served the city for 33 years. In commenting upon his removal and that of Bernard Crozier, the chief engineer of the department, an executive of a large industrial corporation in Baltimore said that the loss of such men by a private corporation would be considered a calamity.

Even the new appointees who are capable men come to their new positions lacking a familiarity with the details of their work which was such a valuable asset to the city in the case of the men removed from office. Others of the new appointees are not as well qualified for their positions as were the men replaced. From a general impression of the situation as gathered from both written and spoken comment in Baltimore, at least in two instances the men chosen as bureau chiefs, while possessing sufficient training or experience to satisfy the minimum requirements for their position, are primarily politicians who do not bring to their new office the qualifications which the occupant should have but come to it with all the disqualifications associated with partisan politics.

Worst of all, politics has been quite definitely injected into the engineering department of a city which has, heretofore, been reasonably free from it. Nor is this the end. The present changes are so radical and unnecessary that they almost assure an attempt to undo them when the city changes government again. This is not a pleasing prospect, especially for the city of Baltimore with large expenditures by its public works department in view.

Open Pier Foundations of St. Louis Telephone Building

Subsoil Exploration and Load Tests—Open-Well Piers Sunk to Rock Through Clay, Sand and Boulder Layers—Basement Walls Built in Trench and Supported on Brackets from Adjacent Piers

By W. J. Knight
W. J. Knight & Co., Consulting Engineers, St. Louis, Mo.

IN BUILDING the first unit of the administration and equipment building of the Southwestern Bell Telephone Co. in St. Louis, some interesting foundation studies and construction methods were applied. After full examination of the subsoil, showing good bearing power in a boulder stratum some distance above rock, it was nevertheless decided, for permanent security, to carry all the foundation piers to rock at about 75-ft. depth. The work was done by open excavation in wells, in place of the pneumatic caissons first contemplated; the bearing area required at the various piers was obtained by filling the wells instead of sinking full-sized shafts.

The building in question is a modern interpretation of the setback style of architecture. It has a front of 229 ft. on Pine St. and extends back 151 ft. in Tenth and Eleventh Sts., occupying 65 per cent of the block extending south to Chestnut St. The unoccupied area of the block is reserved for a future extension, which will duplicate on Chestnut St. the series of setbacks characterizing the three initial street fronts. The ultimate ground area of the building will be 52,269 sq.ft. The central shaft towers 370 ft. above sidewalk and 400 ft. above sub-basement grade. There are 33 floors, including basement, sub-basement and pipe floor.

In the basement story is the cable vault, one of the most essential features of a telephone building, extending along the full length of the north front. The cables enter the vault at the east end and are carried on steel racks along both sides, thence passing up through cable slots in the second floor for final distribution to machine switching units located in the second story. Space is here provided for an ultimate installation of 10 units, capable of serving about 200,000 dial telephones. This installation is served by 210 cables comprising 252,000

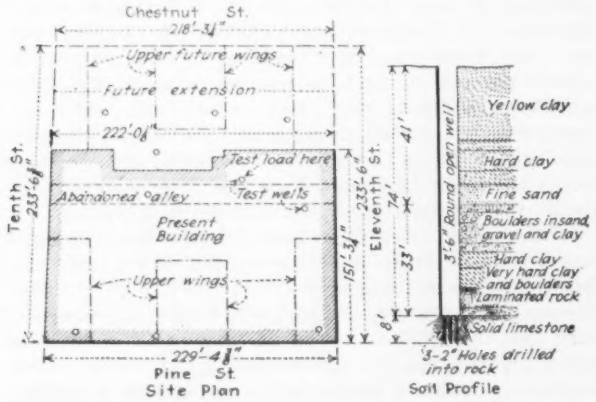


FIG. 1—SITE PLAN AND SOIL PROFILE

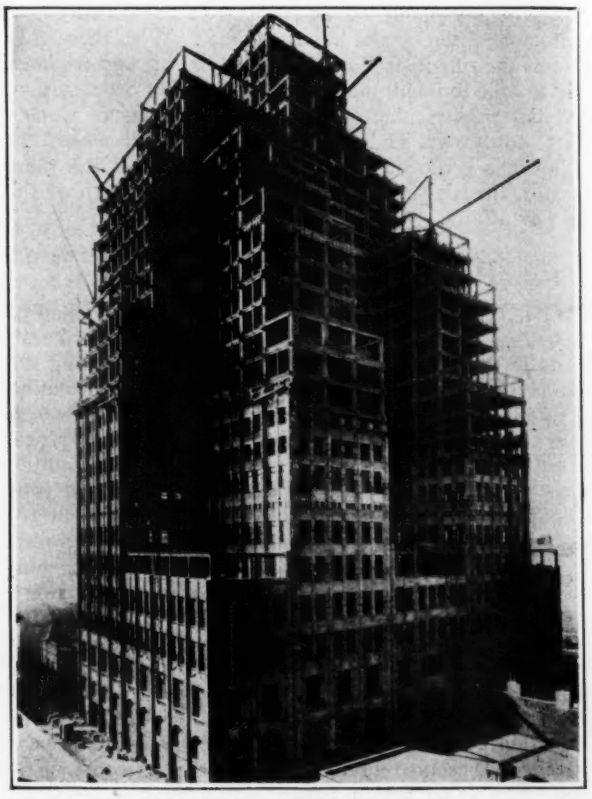


FIG. 2—ADMINISTRATION BUILDING OF SOUTHWESTERN BELL TELEPHONE CO., ST. LOUIS, MO.

pairs of wires (24 gage), not including the cables necessary for house telephones and trunks for connection to other exchanges.

An auditorium seating 500 persons is located in the east wing of the 14th and 15th stories. A modern cafeteria is located in the basement, for the convenience of employees of the company. The commercial business offices of the company occupy much of the first floor. The third floor is reserved for machine switching equipment; the 4th to 8th stories accommodate local departmental organizations of the company and the 17th to 26th the executive offices. For the present, the 9th to 16th floors will be leased to outside tenants until required for the company's business. Two house tanks, aggregating 35,000 gal., are located on the 27th floor.

The gross floor area of the initial building is 602,200 sq.ft. and its volume 8,270,000 cu.ft. The 131 caissons are designed for a load (including static, live and wind

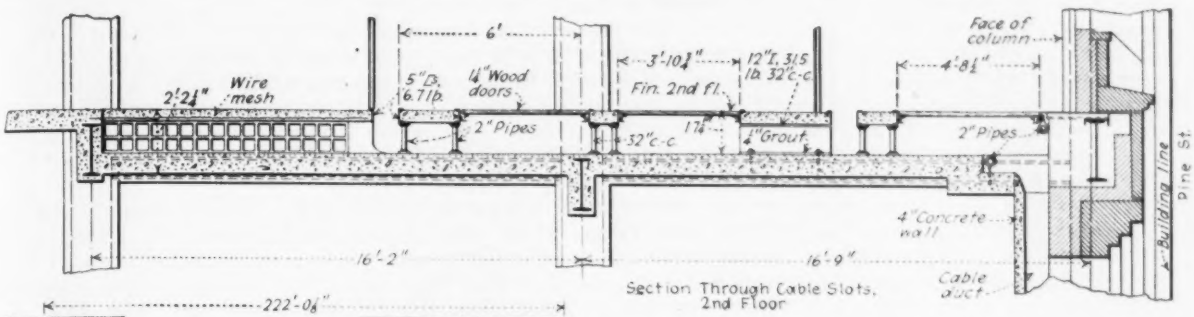
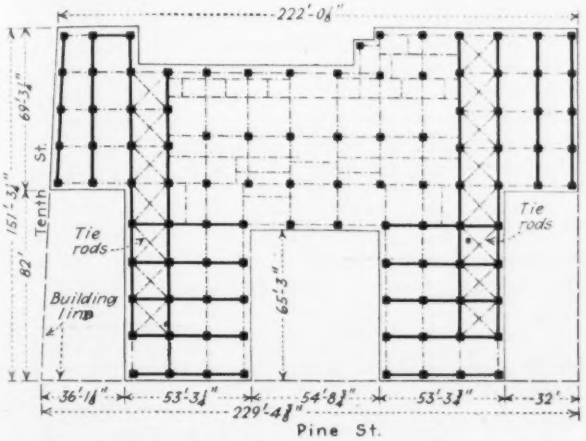


FIG. 4—TYPICAL FLOOR PLAN AND SECTION AT CABLE SLOTS



Typical Floor Plan and Wind Bracing Arrangement

loads) of 112,240 tons. The building contains about 3,100,000 brick, 9,750 tons of Bedford stone facing (on the three street fronts and returns), and 9,290 tons of structural steel (30.85 lb. per sq.ft. of gross floor area, or 2.25 lb. per cubic foot of volume); and 46,700 bbl. of cement, which produced 31,800 cu.yd. of concrete. Its construction required a total of 206,255 man-days, which means that even with all the benefit of modern construction machinery one man would have needed something like 800 years to do the work.

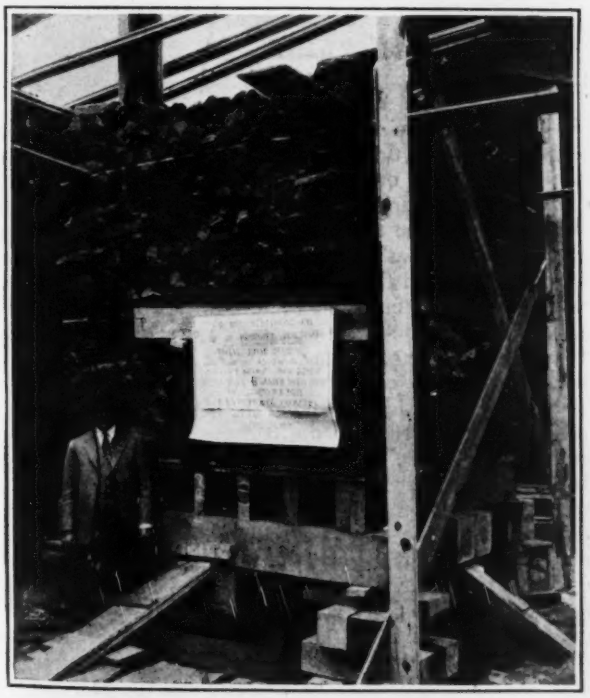


FIG. 3—LOAD TEST ON BOULDER STRATUM

Soil Exploration—Soil conditions at the site called for extensive investigation. Borings with 2-in. augers failed to give satisfactory information, as they brought up (presumably on boulders) 45 ft. below grade, although from conditions in nearby sites it was fairly certain that rock lay much deeper. Test pits 5½ ft. in diameter were therefore sunk, even before the old buildings on the site were removed. There were nine of these wells, one of which reached the top surface of large boulders at 51 ft. but then was lost by collapse of the casing in wet, flowing sand just overlying the boulders. Five were sunk to depths of 25 to 33 ft., 2-in. auger holes being drilled in their bottoms to the boulder formation. Two others were sunk 66 and 74 ft. into boulders, gravel and clay, the deeper one penetrating the boulder stratum and reaching rock.

It was found that 6 ft. of fine wet sand overlay the mixture of boulders and gravel embedded in clay, while the surface material, a yellow clay, changed from hard to soft from the surface to the top of the sand. The boulder formation proved to be the residue of weathering of the underlying Mississippian limestone, this weathering forming in part gravel and boulders and in part the clay matrix in which these are embedded.

Load Tests—It was believed that the foundations of the building might be supported on the boulder stratum, and a load test was arranged, to verify this possibility. In a test well sunk 3 ft. into the boulder formation (or 45 ft. below grade), a loading post consisting of four 8x8 timbers was set, resting through hemispherical steel compression blocks and distributing timbers on a 1-in. steel base plate 2 ft. square bedded on a layer of cement mortar. Settlements were read by gas-pipe rods resting directly on the base plate. A total weight of 63.3 tons on this test surface, or 15.83 tons per square foot, produced slightly less than ⅞-in. settlement, which remained stationary during four days' observation.

Rock Foundation Decided Upon—While the results of this load test were wholly satisfactory, other considerations entered. There was no way of determining in advance the uniformity of bearing value of the boulder stratum over the whole area of the foundations. Further, it was possible that at some unexplored part of the site the boulder formation might cease to exist. For these reasons it was finally determined to avoid all the uncertainties of resting the foundations of this important

building on the boulder formation and to extend all the foundation piers to bedrock.

Experience in foundation work of the nature here involved indicated that many engineers as well as contractors, especially those outside of St. Louis, lean by custom to the use of compressed-air methods even where local conditions do not require the increased expense of this method as compared with open-well excavation. So in this instance the caisson contractor was convinced, when work began, that pneumatic caissons were necescary. We as engineers, having previously carried out many open foundations, were equally convinced that compressed air was unnecessary. A few experimental piers sunk successfully without the aid of compressed air proved entirely satisfactory, and the work proceeded by open excavation to its conclusion.

Sinking Foundation Wells—All piers were proportioned for a loading of 30 tons per square foot on the rock. The required bearing area, however, was obtained

Before concrete was placed in a pier a test hole was drilled 8 ft. deep into the rock at the bottom of the caisson to detect any conditions unfavorable to safe bearing. The deepest caisson extended 76 ft. below sidewalk level. A total of 5,340 cu.yd. of concrete was placed in the piers. Altogether the contract price for the 131 piers amounted to $66.37 per cubic yard of concrete, or $2,710 per pier.

Basement Wall Construction—To simplify the excavation work, the concrete basement walls along the three street fronts were placed first, being built in open trenches averaging 31½ ft. deep and extending to 2 ft. below basement floor level. The trenches were dug 30 in. wide for 21-in. walls and 36-in. wide for 27-in. walls. When the general excavation was started an earth berm was left along the walls until the basement and first floors were in place to afford temporary lateral support to the basement walls. Inclined 14x14-in. timber shores were also set to brace the walls, about 8 ft. below the top, at

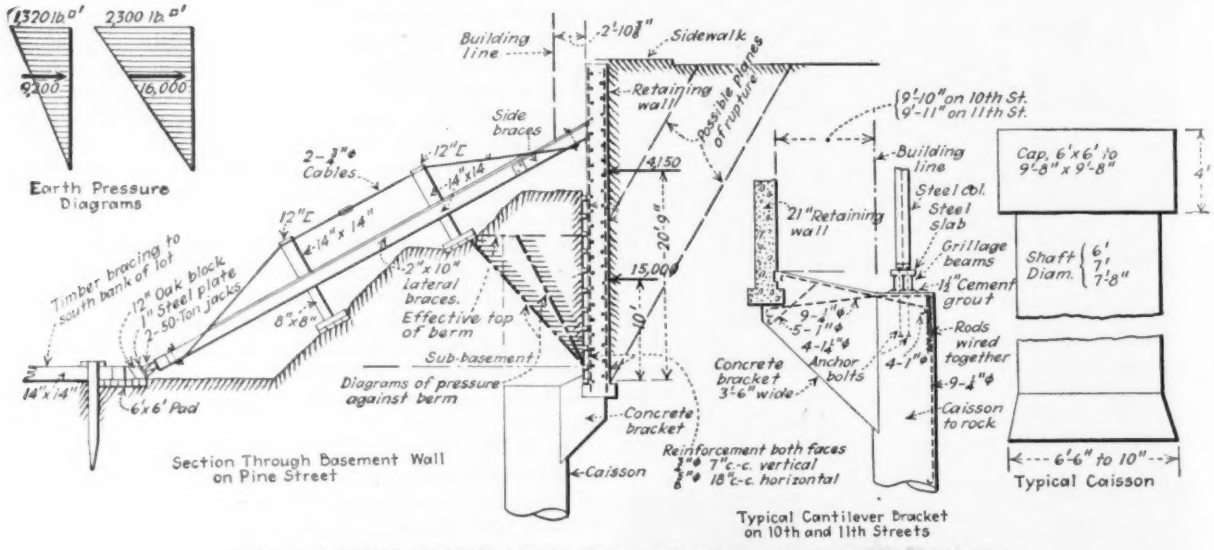


FIG. 5—CAISSON AND RETAINING WALL: ST. LOUIS TELEPHONE BUILDING

by belling the bottoms of the wells, and the shafts above the level of the bells were limited to three sizes, respectively 6 ft., 7 ft. and 7 ft. 8 in. in diameter.

Each well was started by digging an unsheeted pit as far as was safe, and then driving 3x6-in. matched wood casing to refusal, using a 1,500-lb. air hammer suspended by block and chain. As the excavation inside progressed, the casing was driven farther until the layer of boulders was reached, interfering with further driving. Below this point, the larger boulders projecting into the wells were dislodged, or were broken by blasting or by other suitable means, and excavation thus was continued, lining being placed in short lengths ranging from 18 in. to 6 ft. long, depending on soil conditions. The inside of the casing, whether driven or set, was braced with iron bands of semicircular shape, bent at the ends to form bolting flanges; these bands were 3x½-in. for the 6-ft. caissons and 4x¾-in. for the larger caissons, and were spaced a maximum of 3 ft. apart.

During the early stage of the work two open wells were sunk to rock near the center of the lot as sumps to drain the water from the wet sand stratum overlying the boulders. They were left open and were continuously pumped until all the other wells had been concreted.

35 to 40-ft. spacing, their lower ends butting against either horizontal timbers extending to the clay bank on the opposite side or against completed foundation piers.

As it was important to make sure of the ability of the berm to resist the thrust exerted by the backing of the street retaining wall, the earth pressure conditions were investigated. On the assumption that the retaining wall would tend to tip on its base under the action of the pressure behind it, the plane of rupture of the backing was taken at an angle of 30 deg. with the vertical, under two conditions: base of the plane of rupture respectively 15 ft. 9 in. below the top, and at the base of the wall. The active earth pressure of the backing was, as usual, assumed to increase in linear ratio from the top to the bottom of the wedge of rupture, while the resisting earth pressure of the berm was assumed to increase from zero at the base of the wall to a maximum at a point 14 ft. above the base, which point was assumed to represent the effective top of the berm, although the berm extended several feet higher. Under these two assumptions, the maximum pressure of the wall against the berm was found to be 1,320 and 2,300 lb. per sq.ft. respectively.

It was concluded from these results that the wall would be stable with only the support of the berm, until after

the basement and sidewalk construction was in place. However, the inclined timber shores shown in the section were put in place nevertheless, mainly for the purpose of reassuring the public mind.

The basement walls are from 3 to 12 ft. out from the building line, and although they extend down to a depth of 31 ft. below sidewalk grade it was suggested that they be supported by cantilever brackets projecting out from the nearest adjacent lines of foundation piers, in order to avoid any difficulty from future construction of large sewers, subways or the like. Accordingly, reinforced-concrete cantilevers were designed to sustain the load from wall, basement floor and sidewalk, averaging about 90 tons concentrated at the outer end of the cantilever. Wherever the resisting moment from the total static load of the column on the pier was less than 1½ times the overturning moment from the cantilever, a tie member was put in to connect the next adjacent pier. Also, to provide for the possibility that the cantilever bracket might actually support the wall load before the columns on the piers received their load (which is very doubtful), the soil pressure against the face of the pier was investigated.

Structural Framework—Telephone buildings ordinarily are built with a floor 4 to 5 in. thick to accommodate the piping of the mechanical equipment and more particularly the ducts for inclosing telephone wires. After giving considerable study to this problem it was decided to eliminate all floor fill and virtually design the frame about this requirement.

The floor slabs were therefore designed to include within the slab thickness all mechanical pipes and telephone ducts. Where these extended at right angles to the main reinforcing bars of the slab, the metal ducts, 3½x1½ in., arranged in two parallel lines in each panel, were located at the quarter points of the continuous spans, where the diagonal tension and the bending moment are relatively small. The floor I-beams were placed with top flanges 4 in. below the finished surface of the concrete floor, so as to allow for running pipes and telephone ducts in any direction.

Elimination of the floor fill accomplished a saving of about $200,000, considering only such items as the cost of the fill and of the extra structural steel required to carry it, together with the increase in story height.

Floor loads assumed for the structural design were:

First floor	100 lb. per sq.ft.
Basement	150 lb. per sq.ft.
Second to seventh floor	150 lb. per sq.ft.
Mezzanine	60 lb. per sq.ft.
Pipe floor	25 lb. per sq.ft.
Eighth to twenty-ninth floor	60 lb. per sq.ft.
File floor	150 lb. per sq.ft.
Assembly rooms and auditorium	100 lb. per sq.ft.
Roofs	40 lb. per sq.ft.
Penthouse floors, elevator and tank supports	According to service

All structural steel in the building is incased in concrete. Exterior wall columns are fireproofed with a minimum of 3 in. of concrete; brick masonry or brick in combination with clay tile for the protection of steel wall columns is not considered good practice in this section. Floorbeams and girders were designed for a tensile stress of 18,000 lb. per sq.in. The floor slabs (1:2:4 concrete) were designed for a compression of 800 lb. per sq.in. extreme fiber in the concrete and 20,000 lb. per sq.in. tensile stress in the steel (high-elastic-limit grade).

The design of the structural steel framework involved the solution of problems common to buildings of this relative importance, with the possible exception of wind-bracing. The latter was designed according to the portal method, the structure being regarded as equivalent to a series of individual portals. By this method the bending moment in an outer column of a transverse bent is one-half that in an interior column; the point of contraflexure of each wind girder is at its center; and the bending moments due to wind for all girders of any bent on the same floor are alike. This method avoids many complications and presents for the detailer ideal conditions. The exposed faces of the building are designed to resist a wind pressure of 20 lb. per sq.ft. Typical windbracing bents are illustrated by Fig. 6.

The architectural exteriors and ornamental interiors of the building were designed by W. D. Crowell of Mauran, Russell & Crowell, architects, St. Louis. The interior allocation and arrangement of space were carried out by I. R. Timlin, associate architect. All structural

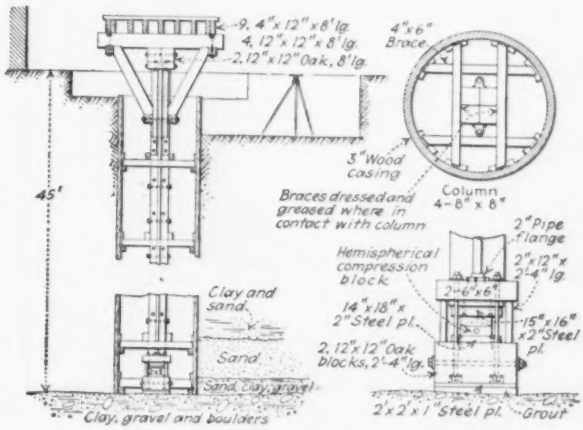


FIG. 6—SOIL TEST LOADING PLATFORM

engineering work was done by W. J. Knight & Co., consulting engineers, and the mechanical engineering by H. H. Morrison. The construction work was supervised for the owners by W. C. Lewis. The Westlake Construction Co. was general contractor. All architectural and engineering work was done under the direct supervision of W. O. Pennell, chief engineer, and I. R. Timlin, architect, both being officials of the Southwestern Bell Telephone Co. Work on the foundations was begun Nov. 6, 1924, and the structure was occupied on Nov. 20, 1926.

Railway Facilities and Train Service

Relations of freight train service to such conditions as track layouts and coaling station were noted as follows at the annual meeting of the Traveling Engineers Association, at Chicago, by J. M. Nicholson, fuel conservation engineer of the Santa Fé Ry.: "The roadway facilities have an important bearing on the number of hours required to move trains from the initial to the final terminals. Among the most important of these are the location of fuel and water stations, efficient blocking of trains, proper length of sidings, double track, facing-point crossovers, adequate signaling, lap sidings and remote control switches. With the establishment of extended locomotive runs, it is desirable to have fuel, water and sand facilities at intermediate terminals so located as to serve both the main line and the terminal, so that it will not be necessary to take engines from the train to the roundhouse to receive such service."

New Railway in Louisiana Cuts Off Long Ferry Transfer

New Car-Ferry Landing on Mississippi—Combined Rail and Highway Bridge Over Atchafalaya River

By Percy F. Lyons
Office Engineer, Louisiana Railway & Navigation Co., Shreveport, La.

TO facilitate the handling of through traffic, the Louisiana Railway & Navigation Co. is constructing a new 20-mile cutoff line from its present station at Moreauville, La., through Simmesport to Red River Landing on the Mississippi River opposite Angola, La.

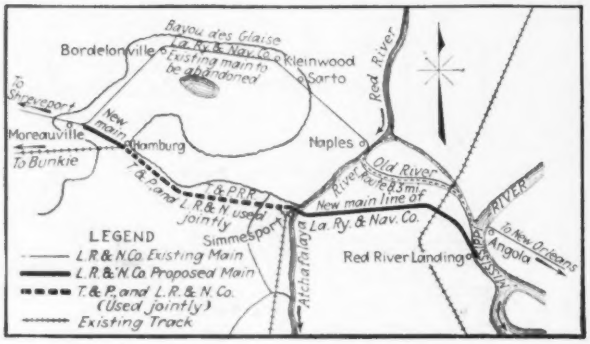


FIG. 1—LOCATION OF NEW LINE OF LOUISIANA RAILWAY & NAVIGATION CO.

This change will eliminate the major part of the present 8.3-mile ferry transfer from Naples out through Old River and thence across the Mississippi River to Angola.

As shown in the location map, Fig. 1, the present main line after it passes Moreauville swings north along the Bayou des Glaises past Bardelonville and Kleinwood before turning south toward Naples in order to avoid the low land between Moreauville and Naples. When the original line was built Naples was selected as a car-ferry terminal as it afforded deep water for an incline and an easy and economical water route to Angola. However, the location at Naples has proved to be costly. The combined waters of the Red and Black Rivers come down past Naples seeking an outlet to the Mississippi through Old River (a cut-off channel of the Mississippi River) or into the Atchafalaya River. When the river is low, the embankment sloughs off, and when the water is high, the embankment washes away. Frequently, transfer boats are tied up for hours on account of dense fog or wind. In the recent high water one of the serious levee breaks occurred near where the L., R. & N. Co.'s line which is to be abandoned passes over the Bayou des Glaises levee near Moreauville.

The new line, known as the Moreauville-Mississippi River extension, will reduce the distance between Moreauville and Angola by 4 miles and will reduce the ferry transfer to 1.2 miles, saving more than an hour for passenger trains and reducing the delays incident to fog and storm. The land crossed by the new line is almost level, and the construction work is light, the average embankment being about 2 ft. in height. By a trackage agreement with the Texas & Pacific, the L. R. & N. will operate over its tracks between Hamburg and Simmesport.

FIG. 3—WEST APPROACH TO ATCHAFALAYA BRIDGE
Crown width of 22 ft. for railroad, 24 ft. for highway. Slopes of 2½ to 1 to comply with levee board requirements.

Before work was begun on the extension, the railway

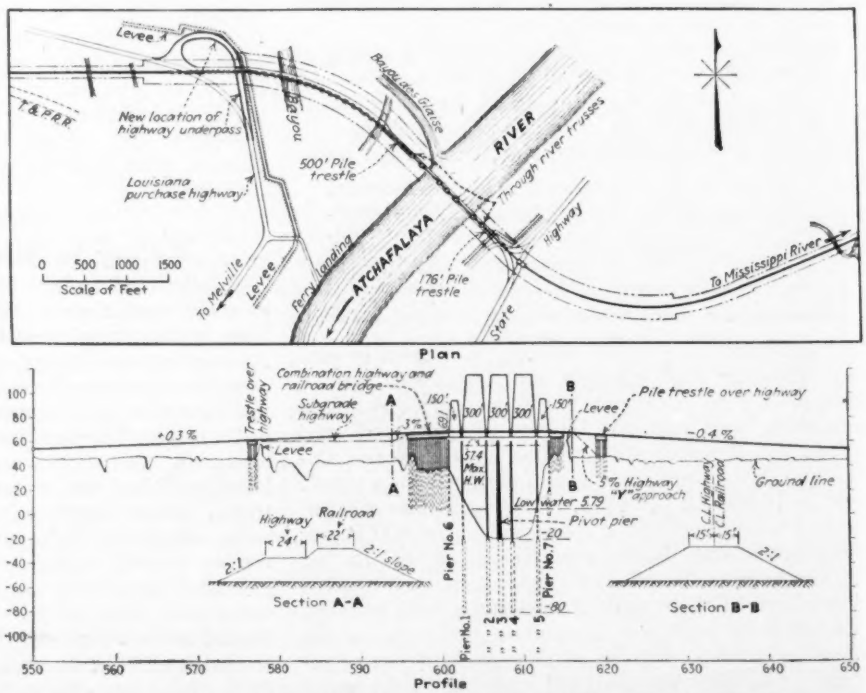


FIG. 2—PLAN AND ELEVATION OF ATCHAFALAYA RIVER CROSSING

entered into an agreement with the State Highway Department to build a combined railroad and highway bridge across the Atchafalaya River, the state to share part of the expense of the approaches and to allow a nominal toll for vehicular and other traffic over the bridge. Also, it was necessary to make some changes in the highway location on each side of the river in order to eliminate grade crossings and provide access to the bridge. In each case the highway passes under the railway just back of the levee.

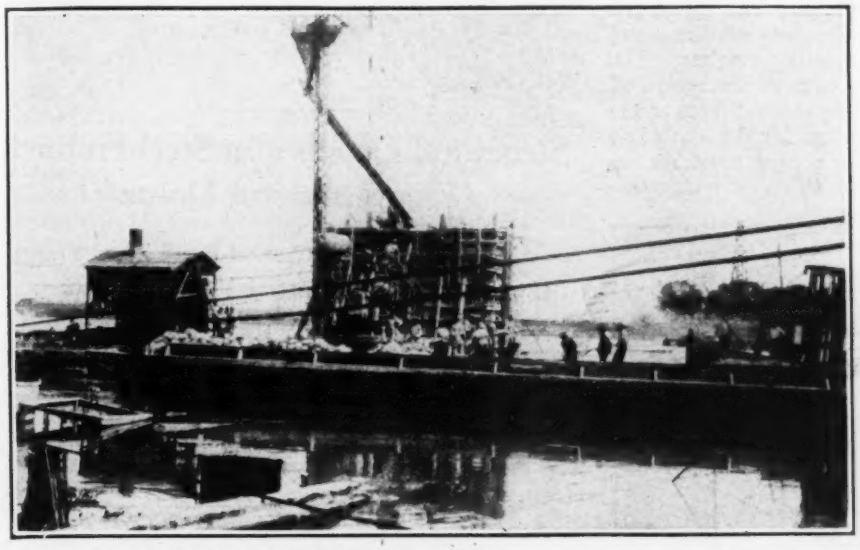


FIG. 4—POURING CONCRETE ON PIER 2
Concrete mixing plant on barge in foreground. One tower of the construction cableway in the right background.

Atchafalaya River Bridge—The crossing of the Atchafalaya consists of two 300-ft. through riveted fixed spans and one 300-ft. through riveted draw span flanked at each end by a 150-ft. through riveted truss and trestle approach. The substructures of the main bridge are of reinforced concrete, the five piers being carried down to El. —80, mean Gulf level. The steel spans are designed for Cooper's E-50 loading with a lateral clearance between hand rails of the trusses of 17 ft. 8½ in. A walkway 3 ft. wide is provided for the entire length of the bridge outside of the trusses on the downstream side. The deck has planking laid flush with the top of the rail to accommodate the highway traffic which crosses the main spans of the bridge on the deck with the railroad. On the long approach trestle at the west end, the highway swings off to a parallel deck at the same level, as shown in Fig. 6.

The railroad company is constructing the substructure of the main bridge over the Atchafalaya with its own forces under the direction of Hedrick & Frost, the designing engineers. This is an unusual procedure for a bridge of such magnitude. It necessitated purchasing a lot of floating equipment such as derricks, piledrivers, steam tugs and barges. The piers, which are of hollow reinforced concrete, were built in place as open caissons, and sunk by excavating from within and building up the concrete walls as they sank to place. Concrete was delivered to the piers by cableways from a concrete mixing plant on the Simmesport side. The mixing plant and a portion of the cableway is shown in Fig. 4. A temporary track approximately ½ mile long, built largely on three-pile frame trestle in order to cross the levee and highway, was required to bring material to the site.

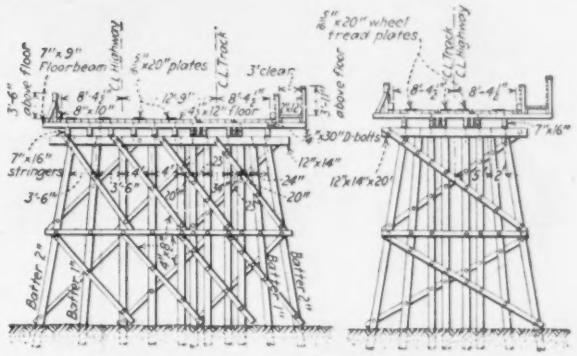


FIG. 6—TYPICAL TRESTLE BENTS FOR ATCHAFALAYA BRIDGE APPROACH

In order to prevent scour in the bed of the Atchafalaya River around the piers, a woven willow mat 1,080 ft. long and 150 ft. wide was sunk at right angles to the river and above a government mat sunk some years ago, overlapping the latter on the upstream side by 20 ft. To sink and hold this mat in position, 1,620 tons of stone were used. Stone

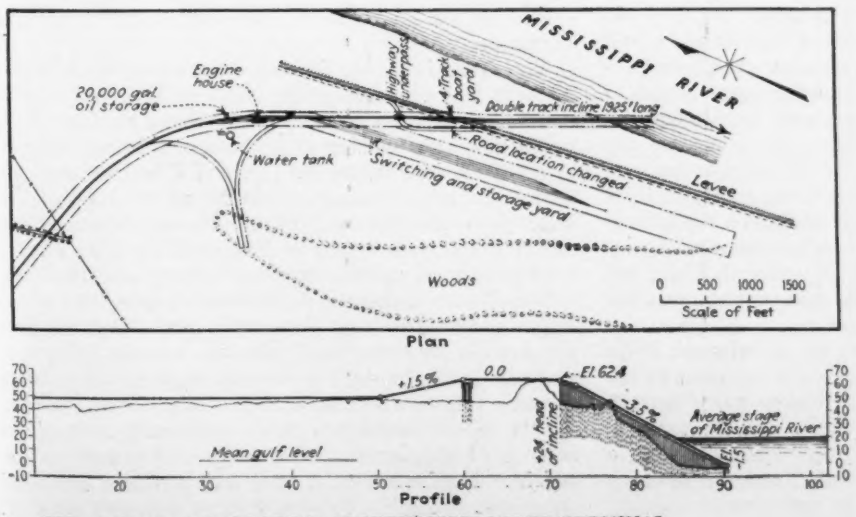


FIG. 5—PLAN AND PROFILE OF MISSISSIPPI RIVER TERMINAL

also was used for the riprap protection at the head of the embankment at the west end of the bridge, extending from the ground surface up the end slope and carried back on both side slopes for a distance of 50 ft. to El. 60.4, which is above the top of the levee.

Grading—Grading on the entire line has been completed. It was done under contract. The earthwork in the Atchafalaya River approaches between the under passes back of the levees was done by dragline. The other work was done by teams, with the exception of some steam shovel borrow for the yard and levee at the Mississippi River. The total yardage for the whole line is 611,600, and the contract price ranged from 20c. to 38c. per cu.yd., the average cost being 20½c. One feature of interest in connection with the grading between the bridge proper and the under-passes east and west of the Atchafalaya River levee is that this is the heaviest earthwork in the state of Louisiana, averaging 7,000 cu.yd. to the station.

FIG. 7—CAR FERRY INCLINE, VIEWED FROM THE CRADLE APRON

The standard embankment has a 22-ft. crown with an added width for two 4,000-ft. passing tracks. Iron pipe was used throughout for culvert openings, and only six standard six-pile creosoted open-deck trestles were built on the whole line for waterways (other than two mentioned trestle approaches), with an aggregate length of 476 ft. Four of these were for drainage ditches between Moreauville and Hamburg. The only grade of any consequence on the new line is that required to get over the Mississippi River levee, 1.5 per cent, and the inclined grade of 3.5 per cent at the ferry landing on the Mississippi River, a section of track which is operated by incline switch engines. The track is laid with 85-lb. rail of A.S.C.E. section on white oak, cypress and creosoted gum, red oak and pine ties.

The layout of the terminal at the Mississippi River ferry landing is shown in Fig. 5. In addition to the incline for the car-ferry landing, which is a double-track structure of creosoted timber 1,925 ft. long, the terminal has a wye, a 400-car classification and storage yard, a 28-car "boat yard," an engine house, and the ordinary facilities for the storage of fuel oil and water.

The estimated cost of the project is $2,000,000. The work is being carried on under the direction of C. R. Mee, chief engineer, with W. F. Duffev field engineer, S. D. Shackelford, resident engineer, and the writer as office engineer.

Contract for the fabrication of the steelwork of the bridge was awarded to the Virginia Bridge & Iron Co., and for the erection to the Wisconsin Bridge & Iron Works. The grading contract was let to the East and West Feliciana Road Co.

Structural Details of a Steel-Framed Hemispherical Dome

Solid-Web Ribs and Horizontal Rings Form Framework of Dome in Portland—Rib Sections Straight Between Panel Points

By Henry F. Blood
Blood & Williams, Consulting Engineers, Portland, Ore.

On the Temple Beth Israel, nearing completion in Portland, Ore., a semicircular dome 85 ft. in diameter has been erected embodying several interesting structural details. The radial ribs use a 24-in. solid-web plate instead of lacing. The horizontal rings, also with solid webs, act as purlins and are made the full depth of the radial ribs in order to permit a good connection to the bottom flanges. On the five lower horizontal rings channels have been riveted flat to the outer flange in order to take the lateral thrust due to the angle of the dome. The covering for the dome consists of a 3-in. concrete slab supported on ¾-in. rib metal lath and further reinforced with wire mesh, the slab being covered with two- and three-ply waterproofing membrane, both radial and horizontal nailing strips, and finally covered with hand-made clay shingle tiles.

The building itself consists of a central portion, octagonal in shape, flanked on one side by a balcony and on the opposite side by the apse. The octagon, with short diameter 90 ft. at the base, has a large concrete pier in each corner extending from the base of the dome to the foundations. There are also intermediate piers on each of six sides of the octagon, the other two sides being at the entrances to the balcony and apse. All outside walls are reinforced concrete faced with brick and sandstone.

The dome is a true framed dome rising to a height of 95 ft. above finished grade with a radius of 42½ ft. to the outside of the steelwork. The frame consists of 16 radial ribs, a tie member at the bottom, a lantern ring or drum 10 ft. in diameter on top, and 7 horizontal rings. Eight ribs have bearing on corbels at the tops of the main piers, six ribs rest on the concrete beams at the top of the wall, and two are supported on plate girders over the arches opening into the balcony and the apse.

The ribs are composed of two outer angles, two inside angles and a ¼-in. web plate 24 in. wide. Rib sections are straight between rings, with the stresses being carried principally by the top or outer angles. Light angle lacing would have been sufficient to unite the two flanges, but the use of a solid-web plate considerably reduced the amount of shop-work, and did not add greatly to the weight. Furthermore the solid web provided increased transverse strength. The lower panel is pushed out 6 in.

from the semicircle at the bottom in order to clear a suspended ceiling. The intermediate rings act as purlins. They also have a ¼-in. web plate the full depth of the rib, this construction being used in place of lacing to reduce the shop-work and also better to resist shear in the lower panels. The five lower rings have channels riveted flat to the outer flange and take the lateral thrust due to the angle of the dome. The seven lower panels in each section are braced with diagonal rods, and between the ribs there are vertical 5-in. I-beam purlins bent to the curve of the dome. The lantern ring at the top of the dome is composed of two pieces of 24-in. I-beam.

The average weight per square foot of dome surface varies from 17 lb. at the bottom to 33 lb. near the lantern ring, and the total weight of steel in the dome, exclusive of the two supporting girders, is approximately 196,000 lb. The dead-load was taken at 70 lb. per sq.ft. exclusive of steel, wind at 30 lb. per sq.ft. and snow and ice at 30 lb. per sq.ft. near the top and 10 lb. per

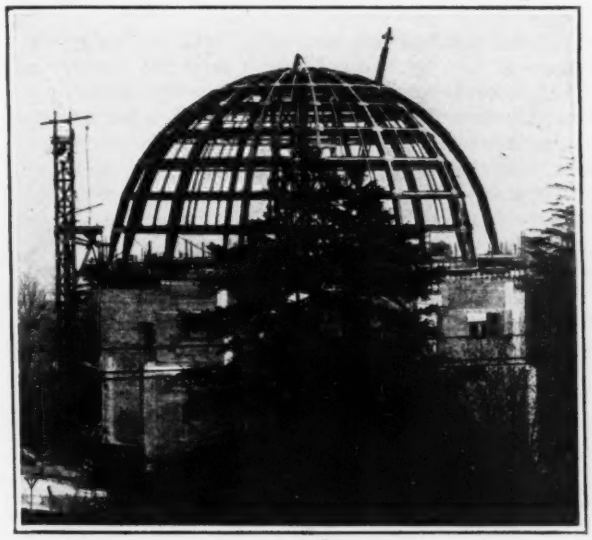


FIG. 1—STEEL-FRAME DOME ON TEMPLE IN PORTLAND, ORE.

sq.ft. on the steep slope. Graphic methods of stress determination were largely used. Loads were assumed concentrated at panel points, while the top ring is always in compression and the bottom always in tension, the stresses in the intermediate rings may be reversed under certain loadings.

Erection—A four-post braced wooden tower was constructed on the auditorium floor, in the center of the octagon for the erection of the steelwork. The legs of the tower were placed over the columns supporting the auditorium floor. A 50-ft. wooden boom attached to one post of the tower at a height of about 50 ft. above the floor first placed the lantern drum in true position on top of the tower, after which each rib was lifted in one piece. A field splice on each rib was made on the ground.

For placing the 3-in. concrete slab a scaffold was constructed over the entire dome supported on the wall at the base of the dome and at the panel points of the ribs and securely tied together by means of horizontal hand rails around the dome. A hoisting tower, shown in Fig. 1, supported one end of a bridge extending over the center to a point 8 ft. above it, from which point all concrete was distributed. After covering the dome with rib metal lath, dry consistency concrete 1 : 1½ : 3 mix was placed in outside sliding forms through three sets of metal chutes. The forms were moved upward 3 or 4 in. at a time as soon as the concrete was poured.

The surface of the slab was covered with a water-

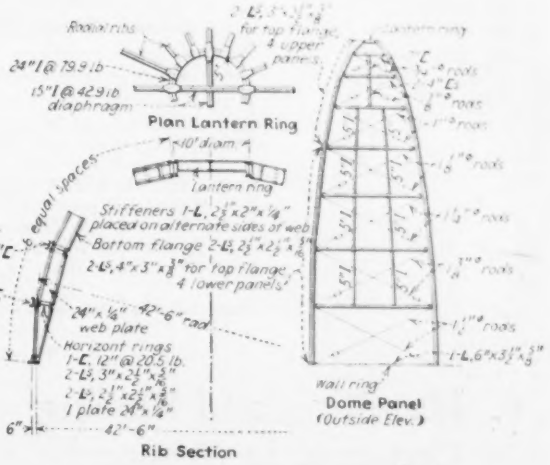


FIG. 2—DETAILS OF DOME FRAMEWORK

proof membrane three plies thick above an angle of 45 deg. and two plies thick below this point. On top of this there were placed 2x4-in. fir nailing strips radially with the dome surface about 3 ft. apart and fastened down by means of ¾-in. bolts which had been set into the slab. On top of these strips there were placed 2x2-in. fir strips 6 in. on centers running horizontally around the dome, fastened to the 2x4's with copper-coated or galvanized screws. The final roof covering was handmade clay shingle tiles attached to the horizontal wood strips with copper nails.

The architects were Morris H. Whitehouse and Herman Brookman, with John V. Bennes and Harry Herzog as consulting architects. The structural design was executed by Blood & Williams, and Parker & Banfield were the general contractors. The structural steel was fabricated by the Pacific Iron Works of Portland.

Developing Sound-Absorbing Plasters

Work is under way at the Bureau of Standards, Washington, to develop a sound-absorbing plaster for use in auditoriums, to prevent the excessive reverberation often produced in such rooms by the high reflecting power of ordinary plasters. It is considered that for this purpose the surface should absorb 10 to 15 per cent of the incident sound. Plasters made with porous aggregate, such as pumice, are already available, but they present mechanical difficulties in application and require very careful workmanship. It has been found, however, that by mixing small amounts of alum and a carbonate such as lime carbonate with the dry mixture of calcined gypsum and sand, an easily working plaster having desired surface porosity is obtained. When the plaster is wet, the alum and carbonate form carbon dioxide, which produces many small bubbles of gas in the plaster. Various fine aggregates have been tried; up to the present pumice, calcined diatomaceous earth and tufa give the best results.

A Series of Eight Articles on

Winter Construction Methods and Plant

BY C. S. HILL
Associate Editor, Engineering News-Record

1. Planning and Servicing Winter Construction
2. Winter Care and Servicing of Equipment
3. Winter Excavation and Embankment Construction
4. Concrete Road Construction in Winter
5 Winter Heating Concrete Materials and Mix
6. Handling and Placing Concrete in Winter
7. Protecting Winter Placed Concrete
8. Winter Inclosure in Building Construction

6. Handling and Placing Concrete in Winter

HEAT put into concrete in mixing has to be conserved in taking it to the forms and putting it into them. This process has been as little perfected as any in winter concreting. It indeed offers great obstacles. The distances moved, the frequent pourings, the operations of spreading, puddling, etc., all expose the concrete to great radiation losses and none of them is easily guarded against by shelter or heating.

Loss of Heat in Placing—The radiation loss naturally varies with the degree of exposure and the time consumed in handling and placing. In ordinary operations it is seldom less than 20 deg. Generally it is least in large volume buckets or other containers handled quickly by motor truck, railway, derrick or cableway. When as in mass work they can be dumped in full loads one after another about as fast as they can come along, another advantage is had. The radiation is greatest when chutes, belts or other continuous conveyors are used. Carriage by barrows or hand carts takes a middle position in heat losses. Determined records of heat loss in handling and placing concrete are not many.

In reconstructing the Spier Falls power plant in New York in 1924 in chuting concrete from the mixer to the hopper of a tremie a drop of 10 deg. occurred in 50 ft. of chute. In a specific case, with the mixing water at 85 deg. and mixing 2 minutes in a flame heated mixer, the concrete left the mixer at 89 deg. and reached the tremie hopper at 60 deg. (C. Voetsch, engineer.) On the Wacker Drive in Chicago, with hand cart distribution, concrete leaving the mixer at 80 to 85 deg. recorded not over 60 to 65 deg. in the forms, the outside temperature being 10 to 20 deg. (Mid Continent Construction Co., Chicago.) On the Lake Humphreys dam in Colorado, concrete leaving the mixer at 80 deg. and carried by wheelbarrows to short chutes into the forms, reached the forms generally at less than 40 deg. A notable record of mixing, placing and hardening temperatures (Table III, p. 547) was kept in erecting a bridge at Waterloo, Iowa, in 1922. The placing was not far from the mixer and the heat loss was small. (G. F. Scales, contractor.) On the Gulf Island dam with carriage in 2½-cu.yd. cars thermometer readings showed virtually no loss of heat in 30 minutes in the car. The temperature at the mixer was 80 deg.; with pouring and chuting it went into the forms at about 60 to 70 deg. With approximately half a mile haul in 4-cu.yd. buckets at Isle Maligne dam on the Saguenay River the heat loss in the containers was inconsiderable. On building construction in St. Louis (Fruin-Colnon Contracting Co.) concrete left the mixer at 60 deg. and got to the forms at 50 deg. losing 10 deg. in an average travel of 250 ft. in tower and chute. No concrete was poured at under 20 deg.

Reheating in Transit—Ordinary methods of handling concrete offer little opportunity for applying heat in transit. On the Chelsea dam near Ottawa, Ont., where side-gate hoppers on steel cars permitted them, wood fires were kept burning on the car tops under the hopper (Fraser-Brace Engineering Co., Montreal). These it is believed cut down the radiation loss through the steel hopper walls. On the Gulf Island dam, box chutes were used and steam lines up the towers and through the chutes kept the concrete stream warm.

Heat Development After Placing—The heat generated by concrete in setting is of practical importance to the winter builder. If it is great enough and lasts long enough to exceed radiation losses to below 50 deg. until the danger period of frost is passed it virtually solves the protection problem. In heavy mass work heat generation is enough to keep the concrete safe from frost except perhaps for a thin surface shell. With light, thin sections, there is not sufficient heat development to offset heat loss by radiation. It is for heavy concrete work that data of heat development are most useful. They are not many and the following records include the more important.

At the Spier Falls dam studies of temperature in the body of concrete placed during January and February gave the results shown by Fig. 23. The readings were taken in grout pipes 1 to 2½ ft. from the exposed surfaces, where the water was at 32 deg. The marked rise of temperature due to chemical action after the concrete was deposited is of interest. (C. Voetsch, engineer.) In building the largest dam of the Lake Kenogami stor-

age reservoir in Quebec in 1923-4, some 7,244 cu.yd. of concrete were placed from Dec. 1 to March 15. During January and February the temperature was seldom above zero, and as a rule varied from 10 to 20 deg. below with a minimum recorded of —35. The concrete went into the forms at about 70 deg. Records of the concrete temperatures after placing showed a rise during the first 24 hours to 120 deg. and then a gradual decline to 32 deg. in three weeks. The record of temperatures given in Table III, in mixing, placing and hardening concrete, was made in 1922 in building an arch bridge at Waterloo, Iowa. Water was heated by steam jet and the mixer by a flame heater for a mixing period of 1¼ minutes. The rise of temperature after placing is to be observed; the figures are an average of ten holes in each pouring. (G.F. Scales, contractor.)

The most complete laboratory tests are those of the Michigan State College in which portland cement, a special portland (super cement) and alumina cement were used. Thermometers were placed in 2x3x2-ft. blocks one near the top, one near one side and one at the center. Fig. 24 is typical of the ten sets of curves secured in these tests. The general conclusions from the tests were as follows:

Alumina Cement: The average temperature for the first 144 hours was approximately 84 deg. F. At the end of this period the freezing point was reached. The alumina cement has a very distinct advantage over other cements

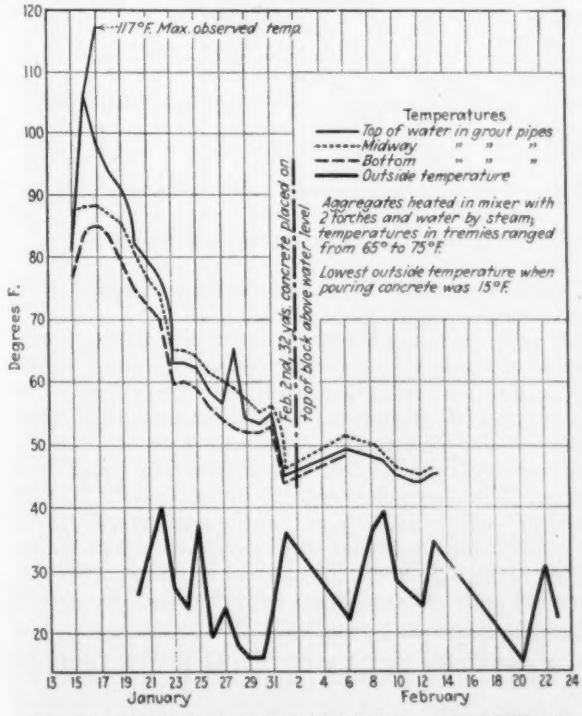

117°F. Max. observed temp.
Temperatures
Top of water in grout pipes
Midway " " "
Bottom " " "
Outside temperature
Aggregates heated in mixer with 2 torches and water by steam; temperatures in tremies ranged from 65° to 75°F.
Lowest outside temperature when pouring concrete was 15°F.
Feb. 2nd, 32 yds. concrete placed on top of block above water level
Degrees F.
January
February

FIG. 23—INTERIOR TEMPERATURES OF CONCRETE AT SPIER FALLS DAM, NEW YORK

for winter concreting in that the rapid chemical action causes high temperature which prevents freezing until such a stage of hydration is reached that there is not sufficient moisture left to form ice crystals.

Super Cement: Twenty-nine hours had elapsed before the temperature reached 70 deg. F., at which time the material would have attained approximately 68 per cent of its strength; and a total period of 140 hours elapsed before the freezing point was reached. This gave a setting period which would place this cement well beyond danger of frost action when poured under such conditions as existed at the time this test was made.

Portland Cement: The time required for this concrete to cool to the freezing point was 130 hours, the average

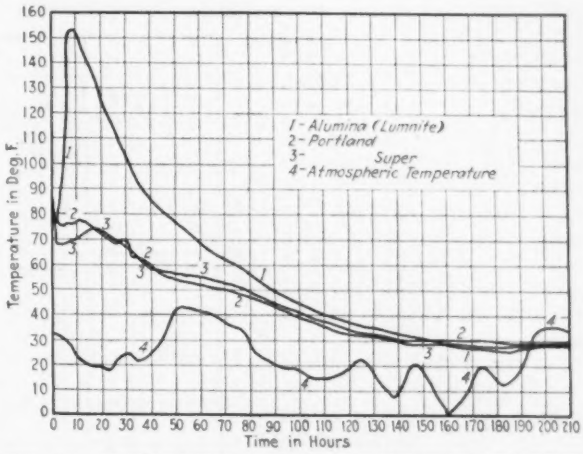


FIG. 24—COMPARATIVE HEAT DEVELOPMENT OF THREE KINDS OF CONCRETE

temperature during this period being 54 deg. The temperature at each 10-hour interval was:

Hours	10	20	30	40	50	60	70	80	90	100	110	120	130
Deg. temp.	71	75	76	71	64	59	54	61	46	42	40	37	35

The temperature for each day until the freezing point was reached was as follows:

1st day average temperature 73 deg. F.
2nd day average temperature 70 deg. F.
3rd day average temperature 59 deg. F.
4th day average temperature 39 deg. F.

It can therefore be concluded that under weather conditions such as existed during the time these tests were made, portland cement concrete, if mixed at a temperature of from 80 to 140 deg. and placed in heavy wood forms, with the surface properly covered, will set sufficiently strong to be past danger due to freezing if no other provision is made for applying heat to the material. It must be remembered, however, that this applies to heavy walls and not to light sections and floor slabs. For full details of the tests the reader is referred to Bulletin 8, Engineering Experiment Station, Michigan State College, Lansing, Mich.

In constructing the anchorages for the Delaware River Bridge concreting operations were carried on during the winters with few interruptions from cold weather. It was found that by heating the aggregate and mixing water to a temperature of 60 to 75 deg. F., the mass would maintain a temperature of 40 to 50 deg. for several days after pouring although the air temperature was between 15 and 25 deg. It was usually found that the temperature would rise 4 or 5 deg. the first 24 hours after mixing, due to the chemical action of the setting of the cement.

Limiting Placing Temperatures—Practice records no temperature to 30 and 40 deg. below zero at which concrete cannot be successfully handled and placed. Perhaps the most extreme test comes in out-door work in exposed dam construction. The winter concreting records of three such operations are given by the graphs Figs. 25 to 27. On two of these dams the protection

after placing was of the simplest form; on the third it was elaborate.

The Saguenay River power development at Isle Maligne, Quebec, furnishes an excellent example of large handling units and cold weather quantity placing in building the first lift of the dam. The mixing plant had two 4-cu.yd. mixers which discharged into 4-cu.yd. buckets hauled four to a flat car and placed by traveling cranes. Fig. 25 shows the output and temperature graphs from November to May, 1923-4. Virtually 100,000 cu.yd. were put in below freezing and much of it below zero with no further precaution than warming the concrete mixture. The large containers with quick handling and quick placing in batch units conserved the heat put into the concrete at the mixer.

At the Lake Humphreys dam in Colorado most of the concrete was placed at below 40 deg. using wheelbarrows and carts to chutes to the forms. The graph, Fig. 26, shows the record. There were no frost troubles, using the materials heating methods and the protection after placing which are described elsewhere. The cost of this protection varied from $1.40 to $2 per cubic yard of concrete protected.

On the Androscoggin River dam operation at Gulf Island, Maine, concrete was taken out into the structure in 2½-cu.yd. cars hauled by gasoline locomotives and then dumped from the cars into chutes to the forms. The chart, Fig. 27, shows the concreting operations during the first winter. The point to be noted is the temperature variation and the fact that placing continued at all temperatures, about 2,300 cu.yd. a week was the average. Totaling everything including rehandling gravel, snow removal, housing and heating, the extra cold weather cost is about 10 per cent of the concrete cost. (Morton C. Tuttle Co.)

Preparing Foundation and Placing Under Water—Concrete should not be placed on frozen ground or on rock covered with ice. When, therefore, foundation pits have been excavated, they should be kept from freezing until concrete is placed or if frozen they should be thawed before concreting begins. Indeed, it is often insisted that rock foundations should be given a thorough warming before concrete is deposited so that the cold rock may not too quickly chill the bottom layer of concrete. In the same line of precaution it is required that the first layer of concrete against the rock shall be thick and of a specially hot mix. Various ways of warming and thawing foundation beds are practiced.

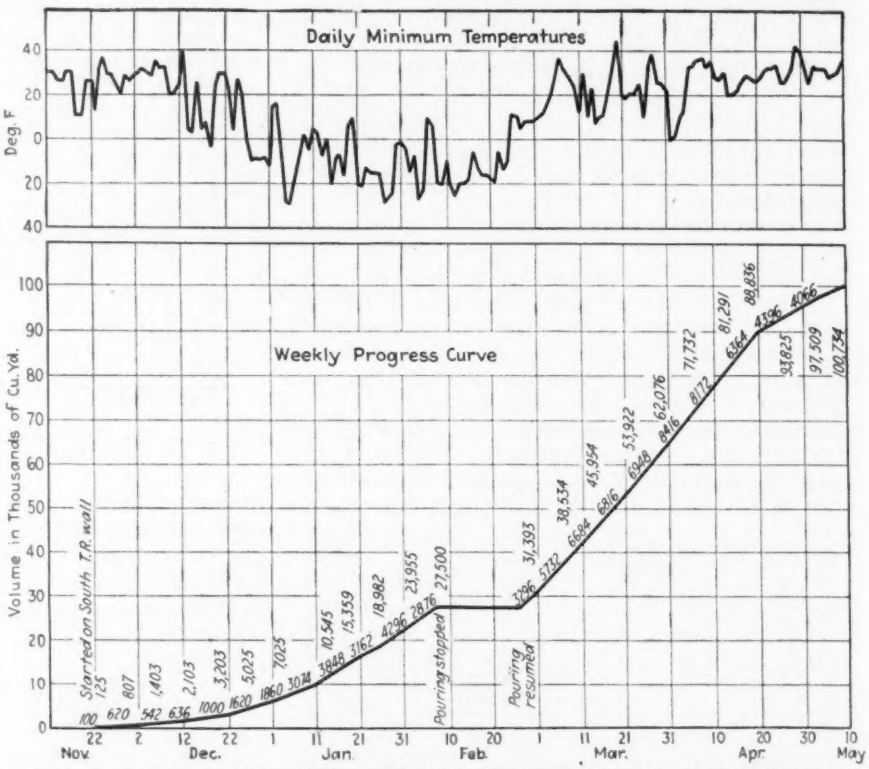


FIG. 25—PLACING AND TEMPERATURE CHARTS, ISLE MALIGNE DAM, QUEBEC

On the Gulf Island dam, the foundation bed to be concreted on the next day was covered with a canvas shelter on staging the day before and this enclosure kept warm by salamanders and steam jets. This thawed and warmed the rock surface enough to remove any ice and then the concrete at 80 to 90 deg. was put on in a good thick layer. The dam was concreted in sections 39 ft. long and the width of dam at the footing ranged up to 80 and 90 ft. A similar method was developed on the Lake Kenogami dams. The section to be concreted was covered over with a large tarpaulin blocked up and

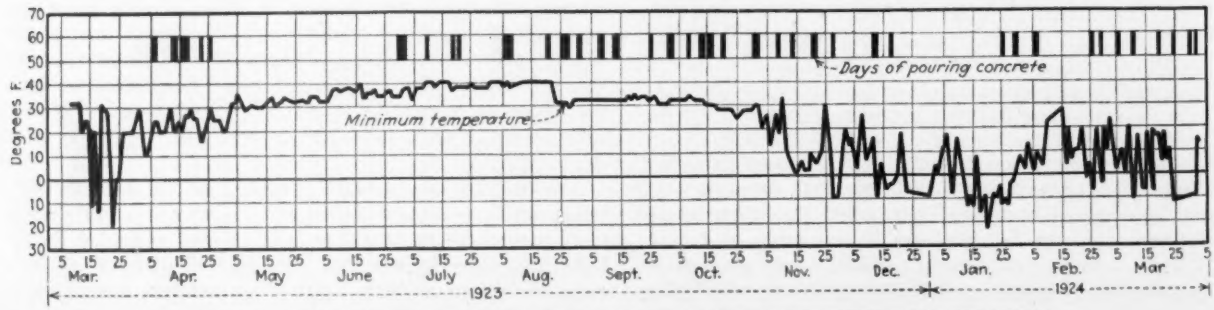


FIG. 26—PLACING AND TEMPERATURE CHARTS, LAKE HUMPHREYS DAM, COLORAO

heated underneath with stoves for at least 12 hours. Heating by steam jet was found less effective than stoves as the escaping vapor readily formed ice. Hot water was found to be the most effective means of removing ice and snow. When concreting was begun it was rushed, 60 to 70 cu.yd. an hour, and it was put in at 70 deg. Virtually the same procedure was followed in preparing placed concrete and forms to take new concrete. Despite the objections discovered at Kenogami to steam jets, they have general approval of contractors for thawing frosted surfaces—foundation beds, placed concrete and exposed forms. Another device useful in defrosting foundation bedrock is the flame heater. This flame heater lessens the water left to re-freeze after thawing while steam or hot water adds to this water. At best the defrosting of a rock foundation in sub-zero weather is not an easy or comfortable labor.

Considerable dependence can be placed and indeed some contractors do place main dependence on the capacity of the concrete deposited warm to defrost the surface against which fresh concrete may be placed. Dam construction on Dead River in northern Michigan in 1917-18 is an observed example. At temperatures below zero more often than above freezing in December, January and February, concrete heated by steam coils in bins and water tank to 40 to 65 deg., average 50 deg., was placed in sections which insured about a 5-ft. lift per day shift. At first at night canvas blocked up was spread over the concrete and steam jets turned on underneath. Except near the jets, the concrete froze. Inclosure and heating was then abandoned and the concrete was left exposed to freeze. This it did—in sub-zero weather to depths of 2 to 3 in. Attempts to remove the frozen top by picking proved laborious and delayed concreting. The frozen layer was then hosed with hot water just enough to thaw the top skin of frozen laitance; hot water proved more effective than steam. The warm fresh concrete was then placed, and observations showed that its heat completely thawed the top frozen layer.

Special methods of placing concrete in water close to freezing have not been often recorded. At the Mystic Lake power development in Montana, where the bottom of the control shaft and some 80 ft. of adjacent tunnel bottom had to be concreted in water at 32 to 33 deg., the tunnel was bulkheaded to inclose the section to be concreted and the water in this inclosure was heated by steam jets to about 45 deg. The concrete went in at about 50 deg. In the work at Spier Falls placing concrete in heavy wall forms under water, the concrete entered the tremie hoppers at 60 to 70 deg. It not only set up perfectly but developed the temperatures given in Fig. 23.

From these experiences it would appear that in confined spaces the contractor can meet the task of cold weather concreting under water by simply using familiar protection methods.

Detecting Frozen Concrete—Concrete should not be permitted to freeze in winter construction. However, like most things which should not be allowed it does occur. The following methods of detecting frost and thawing concrete are based on a discussion by A. M. Bouillon who has had much experience in winter construction in Canada.

The easiest and most certain method to determine frost is to apply warm water or a mild flow of steam against the suspected spot. Cut small inspection openings in the forms, say 3 to 4 in. square. These should be so placed and located as to give positive information to cover all of the concrete faces. The warm water test, or mild steam pressure test, should then be applied over the exposed concrete. If frozen, the concrete will be thawed by this application, becomes soft and crumbles easily.

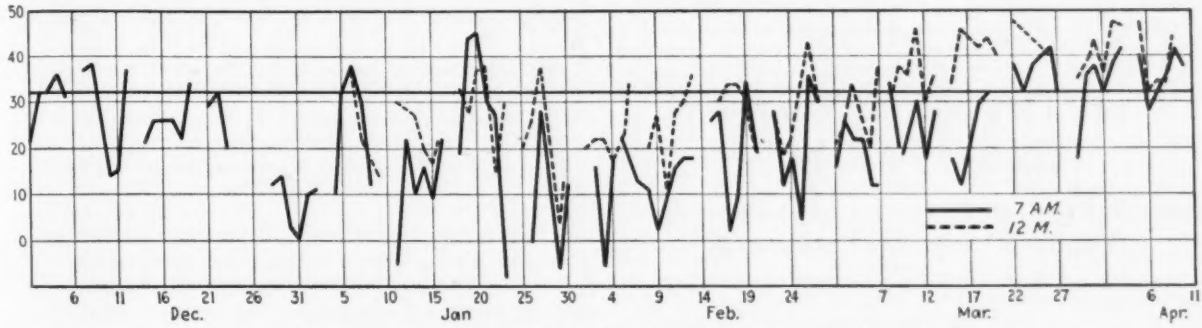


FIG. 27—PLACING AND TEMPERATURE CHARTS, GULF ISLAND DAM, MAINE

Thawing Frozen Concrete—The first step in thawing should be to tighten and strengthen all forms taking into careful account in this operation the height and extent of the frozen concrete which when thawed out will bear pressure against the forms and also any tributary loading due to construction conditions. Coincident with this, there should be provided proper housing and heating to insure gradual thawing and subsequent complete hydration of the concrete. Having taken these protective measures the next step will be either to install ½- or ¾-in. pipes along the top of the forms perforated with tiny holes every foot or two that will provide a flow of water

TABLE III—TEMPERATURES OF CONCRETE, PLACED IN WINTER IN THE SANS SOUCI BRIDGE, WATERLOO, IOWA

Date of Concreting	Outside Air	Sand	Rock	Water	Before Placing	After Placing	After 24 hours	After 48 hours	After 72 hours	After 96 hours	Remarks
Dec. 8 1921	34	34	34	100	75	70					Temperature taken at 8 a.m., 12 m. and 3 p.m.
	35	35	35	113	65	60	90	93	90	85	
	36	36	36	75	70	65					
Dec. 27 1921	2	34	34	170	64	58					Temperature taken at 8 and 10 a.m. and 3 p.m. Concrete mixed 1½ min.
	12	34	34	160	62	58	65	71	77	67	
	26	34	34	150	64	58					
Dec. 28 1921	24	34	34	185	64	63					Temperature taken at 8 a.m., 9 a.m. and 10:30 a.m. Concrete mixed 2 min.
	28	34	34	180	72	65	34	60	58		
	30	34	34	172	63	64					
Jan. 10 1922	16	30	30	145	61	60					Temperature taken at 9 a.m. and 4 p.m.
	33	34	34	160	64	60	64	65	61	59	
Jan. 26 1922	30	30	30	160	63	62					Temperature taken at 9 a.m. and 3 p.m.
	32	34	34	156	66	62	73	79	79	81	

Note: The lowest temperature during the actual depositing of the concrete was 2 deg. above zero, and temperature on following day was 10 deg. below zero.

between the face of the concrete and the forms, or arrange for frequent sprinkling with either hose or buckets.

The thawing operation requires care and good judgment. As far as is practicable it should begin at the extreme bottom of the frozen section, which, if very high, or a building of several stories, should be extended upward very gradually not more than one story at a time. The water to aid in the thawing will insure curing and also prevent cracks or crazing. The actual time required for thawing the concrete will vary according to the extent of the frozen area and its penetration, but usually it takes 24 to 48 hours to get the frost entirely out of a wall 10 to 15 in. thick and it may take two weeks to one month to thaw out a frozen pier 8 to 10 ft. thick. As warmth reaches the concrete it gradually resumes the setting and hardening process that was interrupted by the frost. This warmth must first penetrate through the forms and is greatly assisted by the flow of water previously recommended. Warm water in such instances is, of course, more active than cold water, but cold water is much better than no water. The forms should be kept on until perfectly assured that the frozen concrete has been fully restored, cured and hardened.

Plastic Flow and the Strength of Cold-Worked Steel

Stress Referred to Reduced Cross-Section—Test Results—Correlation of Stress and Reduction of Diameter

By Earle B. Norris
Dean of Engineering, Montana State College, Bozeman, Mont.

IN THE stress-strain relationships for steel it has been quite generally assumed that there are too many factors—chemical composition, crystallline formation and arrangement, heat treatment, and hot and cold working—to permit the deduction of any simple law applicable beyond the elastic limit. Within the elastic limit we have Hooke's law and Poisson's ratio. Beyond the elastic limit no law governing the relations of stress to deformation has been found.

In ordinary tensile tests we observe the yield-point, the ultimate tensile strength (based upon original area), the reduction in area, and the elongation at rupture, and use these as a basis for selection of materials and design of structures. At present, because of the greatly increased use of cold-worked steel, in which the material is modified by stresses beyond the elastic limit, there is need for some usable expression of the relation between stress and deformation, beyond the elastic limit, even though it be empirical. The studies of crystalline structure by means of the X-ray are giving us information as to what occurs within and between the crystals during deformation and may eventually lead to a rational study of the subject.

True Stress and Reduction of Diameter—In the customary stress-strain curve, the axial elongation is made up of a general elongation and a local stretch in the region of necking. Hence the elongation can have no direct relationship to the stress supported by the specimen. It is the necking of the specimen that seems to control the stress supported. It would seem more logical, therefore, to attempt to correlate stress with reduction of diameter at the point of necking.

The late John Stead, the eminent English metallurgist, devoted much of his time during his later years to the study of stress-strain relationships for steel. In one of his last papers, published in the *Journal* of the Iron & Steel Institute for 1923, he gave the results of plotting "true stress" as ordinate against reduction of diameter as abscissa (the expression "true stress," used more abroad than in America, refers to the load divided by

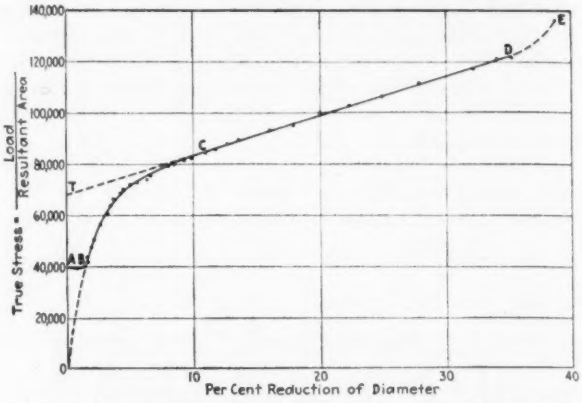


FIG. 1—TRUE STRESS PLOTTED AGAINST REDUCTION OF DIAMETER

the actual reduced area; ordinarily, when we divide load by original area, we get a falling curve after passing the maximum load or ultimate strength; with true stress as ordinate we get a continually rising curve). In the use of cold-worked metal the true stress becomes of prime importance, because the reduced area brought about by the cold working of the metal becomes the working area.

Since the true stress increases with cold working, while the amount of cold working may be represented by reduction of diameter, it is not surprising that Mr. Stead found a rather striking similarity between stress-strain curves for different steels when true stress is plotted against reduction of diameter.

Fig. 1 shows the general form of curve obtained in this way. Up to the yield-point (point *A*) we have no appreciable reduction of diameter, and we have a nearly vertical line. From *A* to *B* we have the flow immediately following the yield-point. Point *C* corresponds to maximum load or ultimate strength as found in the ordinary tensile test. The line from *C* to *D* represents that part of the test in which local elongation and reduction of area occur. When plotted by Stead's method, this section is found to be a straight line nearly up to rupture. The terminal irregularity is probably explained by the fact that the last reading of diameter (*E*) must necessarily be taken after rupture.

Very slow loading is essential to get a true study of the effect of cold working. In the curves presented in this paper a full 8-hr. day was used for the test of each specimen. Mr. Stead reports only that very slow loading was used.

Features of the Curves—A study of Stead's 39 diagrams, together with 10 of the writer's curves (Fig. 2) reveals a significant fact that Stead does not mention. If the straight line from *D* to *C* is prolonged to the left, its

intersection (T in Fig. 1) with the vertical axis is the *ultimate tensile strength based upon original area.* There is some logic in this, because we are referring point C (Fig. 1) back to the original area; but we are using the slope of the line CD displayed by the specimen after the ultimate tensile strength has been passed.

It will also be noted that a logical downward prolongation of the curve CB would pass through the origin. This, too, may be significant as indicating a law of inelastic flow that would be wholly independent of the elastic limit.

Stead used as a general form of equation for true stress in terms of reduction of diameter,

$$S = a + bx - e^{(c - dx)}$$

In this expression, $a + bx$ represents the straight line TD of Fig. 1, while the exponential term represents the deviation of the curve OC below the straight line TC and the entire equation represents the curve $OBCD$. As previously pointed out, the ordinate OT is the ultimate tensile strength of the steel based upon original area,

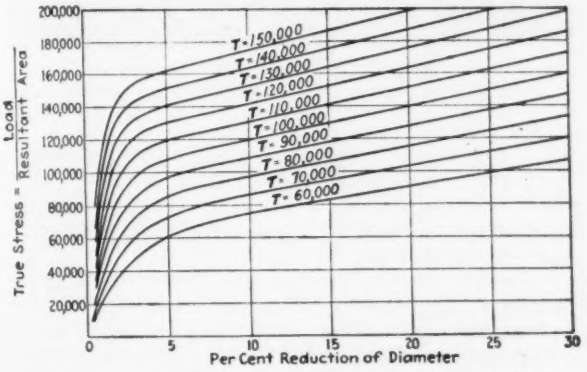


FIG. 2—CURVES OF TRUE STRESS FOR TEN STEELS

and this value, therefore, replaces the constant a in the above formula. The yield-point does not enter into the formula, and evidently has no bearing upon what occurs at higher stresses.

Curves for 10 specimens (diameter 0.505 in.) representing six different chrome and chrome-nickel steels with different heat treatments are given in Fig. 2. They are plotted from data supplied by H. C. Mann of the laboratories of Watertown Arsenal, with the consent of Col. T. C. Dickson, commanding officer, and are published by permission of Maj.-Gen. C. C. Williams, Chief of Ordnance, U.S.A.

A study of these curves shows a general tendency for the slope b of the straight upper part of the curve to be greater for the stronger steels. A close approximation to this variation may be secured by taking b as a function of the ordinary tensile strength T. Further, the value of x at which the exponential term vanishes (point C of Fig. 1) appears to be an inverse function of T. Without going into detail, I find the curves of Fig. 2 to be well represented by the formula,

$$S = T + 0.2\sqrt{T}\,x - T^{(1 - 0.0018\,T\,x)}$$

in which T is the tensile strength, expressed in thousandths of pounds per square inch, x is the number of per cent reduction of diameter, and S is the true stress in thousands of pounds per square inch.

To compare this equation with curves plotted from tests (Fig. 2), its value is shown for three of the specimens ($P\,2$, $T\,2$, and $T\,1$) by dot-and-dash lines, Fig. 3.

In Fig. 3 the equation has been plotted for steels of different tensile strengths. The value of S from these curves, for a steel of any given tensile strength, represents the resistance per unit of final area which the steel will exert at the end of cold working to a given reduction of diameter of x per cent. From the ordinary tensile tests we know that a specimen which has been stressed to a value S beyond its original yield-point becomes elastic up to this same stress S when load is reapplied; in other words, S becomes the new yield-point. Consequently, Fig. 3 should indicate the approximate yield-point of steel which has been cold worked. In the case of drawn wire, these values could be used only where the diameter has been reduced without intermediate annealing, since the anneal removes much of the effect of previous wiredrawing.

For lack of a better name, the equation given might be called the equation of plastic flow. This equation, as I have evolved it, is purely empirical. It may be of interest to consider the possibility of a rational equation.

If each successive equal increment of deformation increased the resistance of the metal by a constant percentage of the previous resistance, we would have the relation

$$dS = k\,S\,dx,$$

whence, by integration, we would obtain

$$S = C\,K^x$$

If we let $K = C^n$, this equation may be written

$$S = C^{(1 + nx)}$$

In comparison with this, my empirical equation for plastic flow may be written in the form

$$S = \frac{T^{(1 + 0.0018Tx)} - T}{T^{0.0018Tx}} + 0.2\sqrt{T}x$$

There is an element of similarity between these two

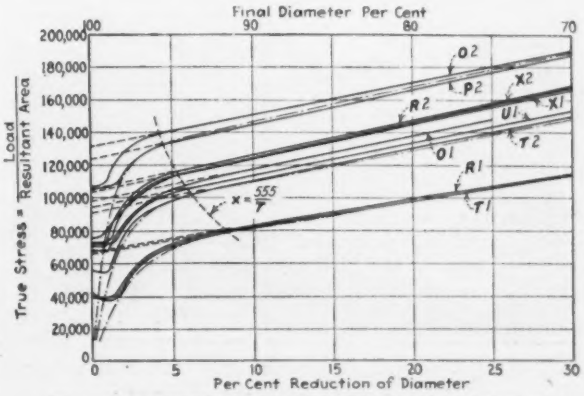


FIG. 3—STRESS-STRAIN CURVES FROM FORMULA

equations which suggests that a fuller study of the subject may eventually lead to a rational law for the relation between stress and deformation. From my empirical equation, it would appear that resistance to plastic flow is a combination of a logarithmic, or exponential, function and a linear function of deformation, the former predominating up to the ultimate tensile strength, as ordinarily determined, while the linear function takes control at higher true stresses.

Narrow Grain Pier Built to Form Unit of Future Pier

Square Foundations of Conveyor Towers So Placed That Intermediate Sections May Be Added to Form One Pier Wall

By H. W. Frith
Chief Engineer to Vancouver Harbor Commissioners, Vancouver, B. C.

IN ORDER to care for the increasing amount of grain being exported through the port of Vancouver, B. C., a long narrow pier, solely for the purpose of handling grain, was constructed there recently. It is known as "No. 1 Grain Jetty" of the Vancouver Harbor Commission. When plans for its construction were under consideration is was thought that a future deep sea pier eventually might be located on the same site to good advantage. With that object in mind, the grain pier was so designed that the west side of the existing cribs could be used to form the west side of the future pier by placing additional cribs between them to form one continuous wall. The east side could then be formed of similar construction and the center filled up to deck level.

The pier as built consists of four cribs of timber and concrete and four groups of concrete cylinders, placed at 125-ft. centers, all forming the foundations for steel towers carrying a conveyor gallery. Filled cribs were adopted for the outer end of the pier because of the depth of water and the severe shocks from vessels in berthing. Groups of concrete cylinders were used for the foundations of the four inner towers because they could be built more cheaply than the heavy cribs and were not exposed to the same severe conditions. The whole pier is 930 ft. long and 56 ft. wide with a pile trestle supporting the deck between the tower supports.

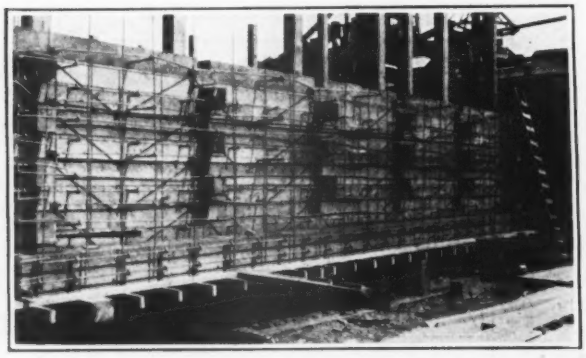


FIG. 1—TIMBER CRIB ON WAYS WITH REINFORCING FOR CONCRETE SHEATHING IN PLACE

The adjoining berths are dredged to a depth of 35 ft. below low water. They provide space for two vessels at the west side and one at the east side of the pier.

In dredging the berthing area it was necessary to remove 179,000 cu.yd. of material, of which 125,000 cu.yd. was cemented conglomerate which had to be drilled and shot. This work was carried out without damage to any existing structures. At a point 40 ft. from the workhouse of the adjoining elevator, and across its entire front, rock was removed to a depth of 38 ft. below the basement floor. At the inshore cylinder group, shooting was carried on 16 ft. out and 32 ft. below the base of the cylinders without any damage to them.

Where excavation was required for the cribs, the bottom was dredged to El. 49, 1 ft. below the elevation of the berthing area. Fine crushed rock was then placed upon the dredged area and leveled to the elevation of the berthing area by sweeping with a heavy I-beam suspended from a frame on the end of a scow, the beam hangers being adjustable to allow for rise and fall of tide. At the outer end where filling was needed, the site was thoroughly cleaned off to the rock and a fill of heavy gravel was placed upon it and leveled with a sweep as noted above. This filling was given an 8-ft. berm on all four sides of the cribs.

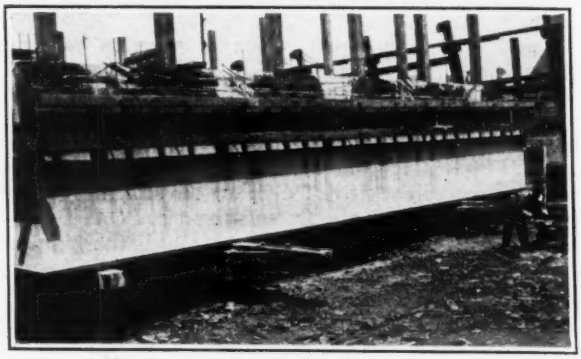


FIG. 2—CRIB READY FOR LAUNCHING
Showing 8 ft. of concrete sheathing poured preliminary to launching.

Crib Construction—Each crib is 56x50 ft. and 56 ft. high from base to coping. The floor consists of 12x18-in. timbers fastened together with 1x24-in. drift bolts at 3-ft. centers. Wall timbers are 10x12 in. set with broken courses and ends mortised. Cross-ties are of the same dimensions with fillers placed to form solid bin walls. The walls and cross timbers are securely bolted with ¾x24-in. drift bolts. Vertical posts 10x10 in. are bolted in position at all intersections. The floor joints are calked with oakum. The timber structure was carried up to a height of 39 ft., at which level a 12x12-in. timber floor was laid to carry the concrete superstructure. Douglas fir was used throughout.

The reinforcing for the concrete sheathing consists of ¾-in. shaped rods laid horizontally at 2-ft. centers and vertical rods placed at the bends of the horizontals. The rods were kept in position and secured to the timber walls by hooked drift bolts placed at frequent intervals. The concrete sheathing, which is 18 in. thick on the side faces of the cribs and 24 in. thick on the berth faces, was a 1:2:4 mix. It was carried up to the timber deck level.

The timber floor and the sidewalls to a height of 10 ft. were built on marine ways, then floated and built up to the timber deck level. Sand filling was put in the cribs as the sidewall construction progressed. Great care was taken in placing the filling to keep the crib floating perfectly level and sufficiently submerged to bring it to rest upon the site for the full ebb of the tide. Each crib was floated into position at a high tide and held by four scows, one on each side. The scows were anchored on long lines in which the slack was taken up by winches as the tide receded. Targets on the cribs were checked as to alignment with transits, adjustments in the position of the cribs being made by means of the anchor lines. When each crib finally settled into place, two flood

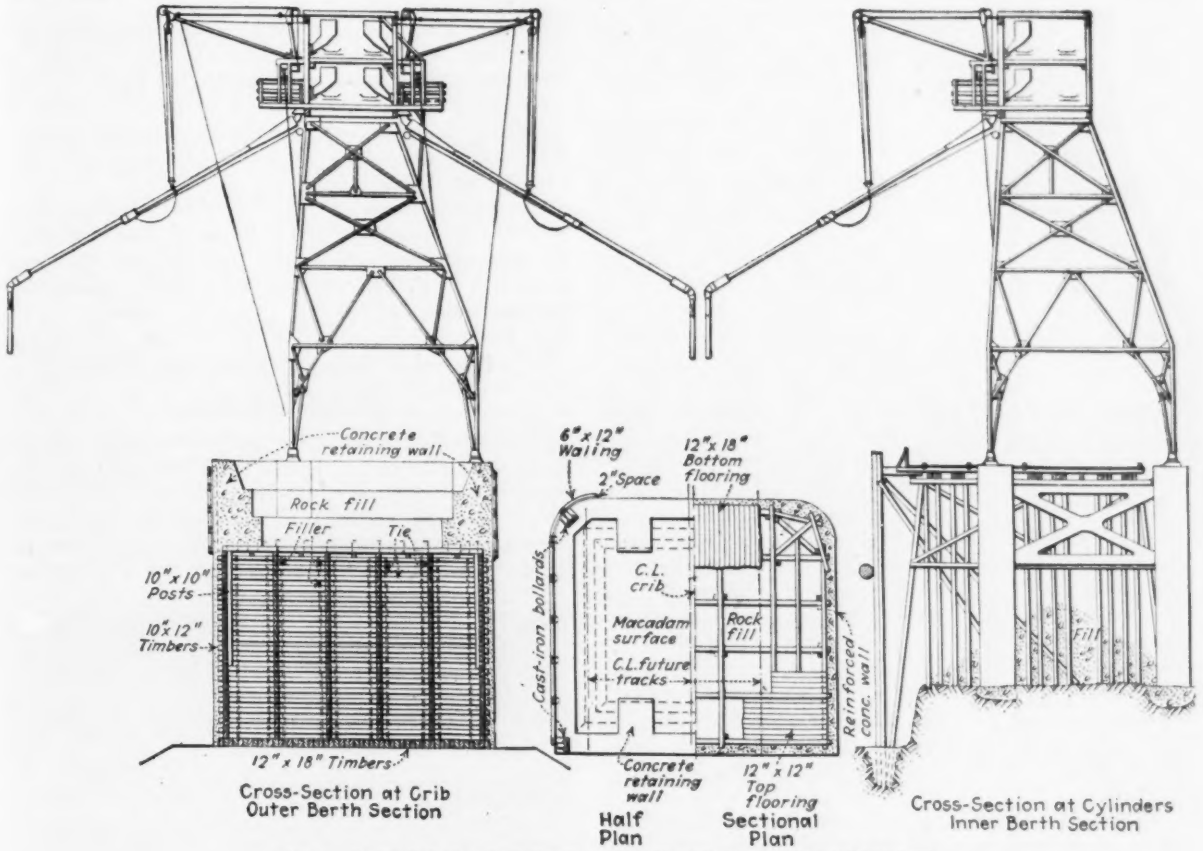


FIG. 3—DETAILS OF THE CRIB AND CYLINDER TOWER SUPPORTS

gates were opened to allow the crib to fill with water. Filling with sand was then completed.

It is of interest to note that with a fill of approximately 16 ft. under the outer crib the total settlement after the day of its completion was 5 in., the settlement being practically uniform over the whole area. During the first month the settlement amounted to 2 in., but continued until the end of the fifth month, decreasing as time passed.

Concrete Superstructure—The concrete superstructure on each of the four cribs was placed by setting forms at periods of low tide and pouring concrete up to the coping

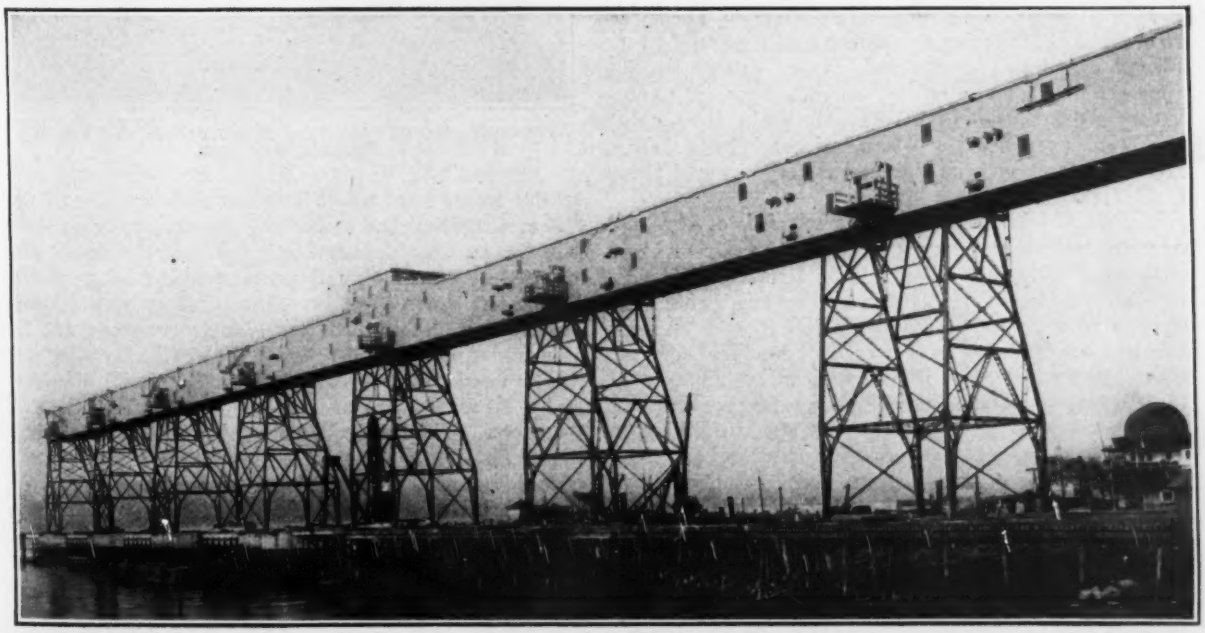


FIG. 4—NO. 1 GRAIN PIER NEARING COMPLETION

level of El. 106. This is 8 ft. above the average high water and is the general dock elevation in the harbor. Sand filling was brought up to the coping level after the concrete had thoroughly set.

The concrete superstructure from the timber deck to the coping, a distance of 17 ft., is in the form of a gravity retaining wall returning on all four sides. It is composed of 1:3:5 mix with 6 in. of a 1:2:4 mix on exposed faces.

Four-Cylinder Piers—After the site of the piers for the inshore section of the pier had been excavated to low water mark, sheetpiling was driven to form a caisson 14 ft. square at the site of each of the four 7-ft.-diameter concrete cylinders which make up each pier. Clay puddling was used in the caissons to keep them as dry as possible but considerable pumping was necessary, especially at high tide, which averages 13 ft. above low water at Vancouver. Inside, the caisson excavation was carried to the required depth for the various cylinders, forms were set and concrete poured in the dry.

Four cylinders placed at the corners of a 35-ft. square comprise each group of small piers, making up the large pier. On the two inshore groups, the cylinders of each group are tied by light reinforced beams and kneebraces. In the case of the outer two groups, where the rock foundation was at a much lower level, heavy reinforced-concrete trusses were used between each pair of cylinders. In cross-sections, the beam members are 18x30 in. with three courses of 1⅛-in. square twisted reinforcing rods. Reinforcing in the diagonal members is interlocked top and bottom.

The lower half of each truss was precast above high water on blocks immediately above its final position, slots having been cut in the upper portion of the cylinder forms to receive the beam ends. When the concrete was sufficiently set, the half truss was lowered into place and the cylinder poured to a point midway between beam ends, making the lower chord of the truss one with the cylinder. The upper half of the truss which was above high water was poured in place, the cylinder and truss being a continuous pour.

Superstructure and Conveying Equipment—The superstructure and conveying equipment consist of steel trestle towers carrying a double-deck timber gallery housing four shipping conveyors, two on each floor. The conveyors are arranged to handle bulk grain from either the Vancouver Harbor Commissioners' 2,050,000-bu. No. 1 elevator or from the Vancouver Terminal Grain Co.'s 2,000,000-bu. elevator.

The shore or connecting gallery which is of steel and concrete extends east from the Vancouver Harbor Commissioners' shipping elevator No. 1 to, and directly through, the bins of the Vancouver Terminal Grain Co.'s elevator to a point approximately 100 ft. east of these bins to a tower known as Tower A of steel and concrete above the track shed of the Vancouver Terminal Grain Co.'s elevator. The shipping gallery proper then extends north along the axis of the jetty and at right angles to the shore gallery. The first shipping gallery truss from Tower A is of structural steel, forming a fire break between the grain elevators and the timber trusses of the galleries above the pier proper.

The pier gallery system delivers grain to three berths by four 36-in. conveyors each with capacity of 15,000 bu. per hour, giving a maximum of 60,000 bu. or 1,800 tons per hour. Grain is delivered by traveling trippers to the usual type of telescoping dock spouts which are operated from winch balconies projecting from the gallery at the lower belt level. Roller bearings are used for the belt conveyor rollers and for the head and tail pulley shafts to obtain a 40 per cent reduction in the power over that required by the old type of babbitt bearing. Electric interlocking signals provide a complete system of control of all shipping operations.

Personnel—During the period of construction of this pier, W. G. Swan held the position of chief engineer to the commissioners, the author was assistant chief engineer, and F. B. Dill was resident engineer in charge of construction.

Circular Precast Concrete Block Pavement Base

PRECAST concrete disks and filler blocks doweled together and surfaced with wood blocks as shown by the accompanying view, receive high praise in a report of the borough engineer of Hampstead, London, as a pavement for places where heavy buses start and stop. As described in the report, the road bed was prepared

SECTION OF PRECAST CONCRETE BLOCK PAVEMENT, LONDON, ENGLAND

to the proper level and a layer about 1 in. thick of fine dry concrete was laid as bedding for the concrete blocks. The blocks were then carefully laid and the dowel pins inserted into the holes, left for the purpose in the blocks, keying the blocks together. The surfaces of the blocks were then finally grouted over with cement grout, and the foundation was ready to receive the surfacing.

The main concrete blocks are disks 2 ft. in diameter, and 6 in. thick, and have a 1-in. diameter hole through the center. They are suitably reinforced at top and bottom. The intervening spaces between the four juxtaposed disks are filled by blocks similarly precast. The blocks after manufacture are stored for at least three months, so that they are thoroughly matured before use. This permits the paving to be opened immediately for traffic directly it is completed.

This construction is known as the Spagnaletti-Grunspan system and we are indebted to A. S. Grunspan, London, England, for information concerning it.

High Density of Snow Accelerates Its Melting and Runoff

Snow Conditions in the Rocky Mountains Affect Water Supply in Streams for Power, Irrigation and Other Uses

By J. E. Church, Jr.

Director, Nevada Co-operative Snow Surveys, Reno, Nev.

In forecasting the runoff from mountain snow fields there has been an old maxim of "early snow, late runoff," meaning that high density of snow retards melting. That this idea is erroneous has long been held by those engaged in snow survey work, investigations showing that high density of snow actually accelerates the melting. The latter condition was shown convincingly during March, 1923, when with normal conditions of temperature and depth of snow, the snow cover in the central Sierra Nevada, though possessing a super-density of 4.1 to 8.5 per cent, lost 7.4 to 23.4 per cent of its normal water content. The cause of the super-density and premature runoff lay in the lack of sufficient new snow during February-March to insulate the older snow against weathering and by its greater porosity to hold in suspension the water formed by surface melting. Furthermore, an investigation of records of the Carson Basin for the years 1909-1916 failed to show a single year in which super-density unmistakably caused retardation in runoff. On the other hand, deficient density appeared to have this effect.

Density, Temperature, Level and Runoff — During these years, 1909-1916, the snow cover varied from 49.9 to 167.5 per cent of normal. The maximum variations from normal density and temperature were 12.2 per cent and 7.5 deg. F. respectively. The month of maximum runoff varied from March-April to June-July, while the normal month was May. In 1909-1910 and 1914-1915, which were years of similar snow cover, an excess of 3.3 per cent in density and 7.5 deg. in temperature, in 1909-1910, caused an acceleration of runoff to March-April; while a deficiency of 5.2 per cent in density in 1914-1915, in spite of 2 deg. excess in temperature, delayed the maximum runoff until June.

Again, in 1913-1914 and 1911-1912, when the densities were most extreme, an excess of 12.2 per cent in density and 4.2 deg. in temperature in 1913-1914 was followed by neither retardation nor acceleration in maximum runoff. The snow cover of 154.1 per cent of normal evidently was the controlling factor. On the other hand, in 1911-1912 a combined deficiency of 9.5 per cent in density and 1.2 deg. F. in temperature, despite the small snow cover of 49.9 per cent of normal, caused a retardation of maximum runoff until June. Finally, in 1910-1911 and 1912-1913, when the snow cover was extreme but the temperature was normal, the maximum snow cover of 167.5 per cent, with an excess of 2.4 per cent in density, retarded the maximum runoff until June-July. But a snow cover of only 58.3 per cent of normal, with a deficiency of 8.2 per cent in density, failed to cause any acceleration.

Belief that increase in density retards runoff evidently started in the lowlands, where newly fallen snow quickly fades beneath the sun, while old snow (often hardened into ice) persists. The fact that the hardened snow was the remnant of a drift or had been protected by shade was apparently overlooked. Hard snow is like ice in its inability to hold its melting water in suspension, and the denser the snow, the more incapable it becomes. On the other hand, the lighter or more porous the snow, the longer the delay before the melting or seepage begins.

Effect of Ripening of Snow—In the development of snow surveying, the term "ripe snow" was coined for snow approaching the point of saturation. However, the density at which snow ripens depends upon the conditions under which it is laid. Near the crests of the mountains, where the snow crystals are usually ground fine by the wind, the density of the snow, except in sheltered places, is always high, irrespective of temperature. Its density increases only about 10 per cent, as from 40 per cent initial density to 50 per cent final, during ripening. At the lower levels, with shelter from wind, the snow increases in density mainly by gravity and temperature. The former affects the entire mass, while the latter affects mainly the surface, except as water percolates downward. At these levels, the snow gradually increases in density to a maximum of approximately 35 per cent, when the coarse structure of the snow prevents further increase in capillarity.

A cross-section of the snow cover at Summit Station, midway between the higher and lower levels, shows the stages of stratification and increasing density. The measurements were made by the writer in 1917. On April 1, this cross-section had a depth of 124.1 in., with a water content of 56 in. and a density of 45.1 per cent. On April 23, the depth had shrunk to 109.3 in., but with a water content of 53.5 in. and a density of 48.9 per cent. Thus a loss of 13.8 in. depth had caused a loss of only 2.5 in. water content, because the capillarity of the upper 2 ft. of snow cover, the density of which varied from 24.6 to 40.7 per cent, had furnished a snow reservoir during three weeks while the entire snow cover was attaining maximum density.

Density and Evaporation—The deterrent to premature melting of the snow cover is obviously a stratum of soft snow sufficiently thick to absorb the effect of heat and prevent both heat and percolating water from reaching the denser layers below. The question of the relative rate of evaporation from soft and hard snow still remains, but it is practically unessential because the normal rate of evaporation from snow is itself low. The rate of melting at the surface of soft and dense snow is also unessential, because all snow must "ripen" before runoff occurs. However, it will be an interesting experiment to test the melting of two sections of snow, both identical in water content and in area of exposed upper surface, but one of high and the other of low density. One must naturally be thicker than the other.

River Flow Records in Missouri Basin

The U. S. Geological Survey maintained in the Missouri Basin during the year ending Sept. 30, 1923, 210 gaging stations, at most of which were obtained records of daily flow of the Missouri River and its tributaries. These data have just been published as Water-Supply Paper 566, which is largely statistical and covers 360 pp. and which may be purchased from the Superintendent of Documents, Washington, D. C., for 50c. The gaging stations were maintained in co-operation with the states in the Missouri Basin.

State Highway Ferry Service at Straits of Mackinac

Michigan Highway Department Serves Increasing Inter-Peninsula Traffic by Operating a State Ferry—Revenue Gratifying

By M. DeGlopper
Assistant Construction Engineer, Michigan Highway Department, Lansing, Mich.

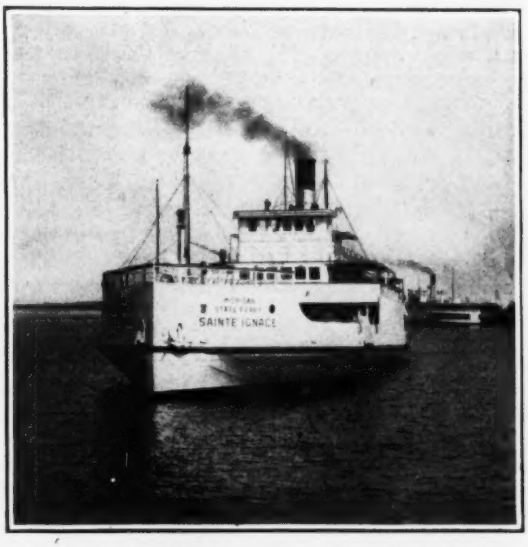
The operation and administration of the state highway system in Michigan involves a feature which is considered unique in the field of state-controlled transportation facilities. Incorporated into and operated as a direct link in the highway plan is a unit of marine transportation which has attracted considerable attention and favorable comment.—G. C. Dillman, *Deputy Commissioner-Chief Engineer, Michigan State Highway Department, Lansing, Mich.*

A GLANCE at Michigan's geographical outline discloses its division into two peninsulas at the Straits of Mackinac, the connecting waters between Lake Michigan and Lake Huron. Fifteen of the eighty-three counties of the state, comprising about 30 per cent of the total area, lie north of this natural line of separation, and include those sections of the state which are rich in copper, iron ore and forest products. The Upper Peninsula, being entirely surrounded by water, excepting where in contact with Wisconsin on its southwestern boundary, is in close proximity to the Lower Peninsula at only one point, the actual intervening distance here being about four miles, but requiring a route 7½ miles in length for all practical purposes of transportation by navigation.

The lack of a direct-connected and unbroken system of highways between the peninsulas has, as a consequence, had an appreciable effect in disrupting social, commercial and business intercourse. The mutual understanding of each other's problems, the exchange of ideas and reasoning in business, and a widened conception of the needs of the commonwealth as a whole were matters of mutual desire, but of restricted and limited attainment. For many years the only direct medium of transportation between the peninsulas had been through railroad connections by way of an auxiliary car ferry service at the straits. The lack of accommodations for motor vehicles, the uncertainty and inadequacy of operating schedules, and the excessive transportation rates which were exacted under privately operated systems, had created a natural indifference to intercourse between the peoples living under a common government.

With the coming of an intensive motor traffic, the state was quick to realize the advantages and benefits that would result from the adoption of state-owned and state-operated facilities, and the crystallization of sentiment to this end resulted in 1923 in the passage of enabling laws. The sole purpose in the adoption of this plan was to provide the means of rendering a much needed service, a service in fact as well as in theory. It was believed that such a service could be assured only through and by state management. The nature of the enterprise was therefore similar in motive to that which activated the highway policies and the natural conclusion was to place the operation of the new facility in the hands of the State Highway Commissioner. The plan of operating the marine unit on a self-supporting basis met with immediate favor and without objection to the establishment of rates that would be commensurate with the service provided.

The enabling act provided an initial appropriation of $150,000 for use in the purchase of ferry craft and to cover other capital charges. Terminals were established at Mackinaw City and St. Ignace and service was initiated on July 31, 1923. The steamer Ariel, secured at a cost of $19,500, started operation on a three-hour schedule with a trip capacity of twenty vehicles. Landing facilities were secured for temporary use during the period required to construct the home docks. At Mackinaw City a new pier was extended into the straits for a distance of 1,300 ft., including land approaches. The construction was of the rubble type and carried a 20-ft. concrete roadway and



STEAMER OF STATE FERRY AT MACKINAC STRAITS

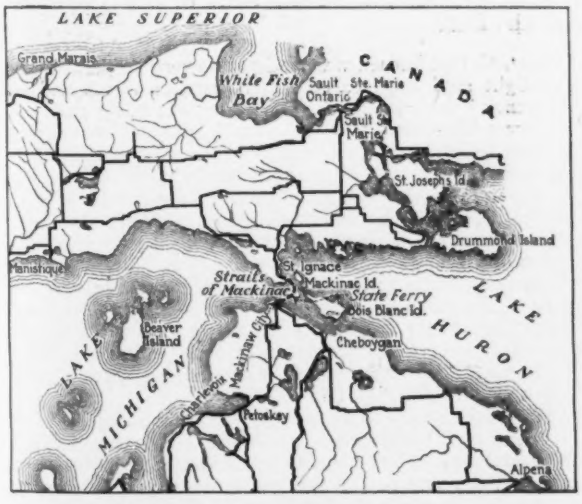
5-ft. sidewalk to the docks at its outer end. With the outer walls and lighting columns constructed of selected field stone, the appearance of the structure is in esthetic keeping with the requirements of beauty on a project of this nature. Rest stations of suitable design, constructed at both terminals, add to the completeness of the system. The pier and docking facilities, including improvements ashore, required the expenditure of $176,000.

The initiation of service met with immediate response on the part of the expectant and long patient public, and the increase in tourist traffic in particular was accelerated to such an extent that successful operation was immediately assured. Within one month after the inauguration of service it became apparent that additional craft of increased capacity would be required for the second year of operation, and authorization was granted for the purchase of new boats. The assistance of reputable marine men was mainly responsible for the state's being able to secure two small coastwise transports which had been built for the federal government during the war period. These boats, having a length of 130 ft. and beam of 26 ft., were purchased at a price of $15,000

each, and were brought up from Halifax through the St. Lawrence River and docked at the yards of the Great Lakes Engineering Co. at Detroit, for alterations to fit them for the ferry service. During the winter season of 1923-24 these boats were lengthened to 180 ft. at a total cost of $115,250, the improvements resulting in an increased capacity of 250 per cent over the loading of 1923. Each boat with a rated capacity of 35 vehicles was operated on a three-hour schedule alternating so as to provide service every 1½ hours from each side. The original names of the transports, the "Colonel Pond" and "Colonel Card," were changed and the boats were re-registered as the "Sainte Ignace" and "Mackinaw City."

During the seasons of 1924 and 1925 the rapid increase in traffic demands was continued to the point where inadequacy of capacity was again experienced. The boats were once more returned to the yards during the winter season and the beam dimensions were increased from 26 to 42 ft., giving an additional capacity of 21 vehicles to each carrier. This work was performed by the construction of new outside hulls flaring out from above the keel line and leaving the original hulls intact. This work was completed at a total cost of $103,830. During the 1926 season both boats were operated from May 5 to Dec. 3, each having an average carrying capacity of 56 vehicles.

Through the months of July and August, during the resort season, and for two weeks in November during the open deer-hunting season, the accommodations were taxed to the capacity limit. Due to the greatly diminished traffic during the winter months and the extreme difficulties encountered in keeping an open passage through the heavy ice fields, the operating season has been limited to the period approximately from May 1 to Dec. 5. During the winter period, service is afforded on



MAP OF STATE ROADS TO MACKINAC FERRY

the larger and more powerful privately-owned car ferries which are equipped to meet ice and other conditions during these months. It is very probable that the next extension of the service will be provided to take care of this condition by placing in operation a faster boat of the ice-crushing type so that traffic may be accommodated through the entire year.

Since the beginning of service in 1923 there has been one appreciable reduction in transportation rates and additional reductions are anticipated as soon as the dockage and steamer requirements have been placed on a self-supporting and permanent basis. The present rates as effective for 1926 and 1927 over the nine-mile route are as follows:

Passenger Vehicles (Rates based on overall length)—13 ft. and under, $2; each additional foot up to and including 18 ft., $0.50; motorcycles, $1; with side cars, $1.50; wagons, $2.50; horses unattached, $2.50.

STATE FERRY WHARF AT MACKINAW CITY

Motor Trucks (Rates based on rated capacities)—One ton and under, $3; each additional ton capacity, $1.50; truck trailers under one ton, $1.50; trailers over one ton, same rate as truck.

Vehicular passengers, up to the seating capacity of vehicle, are carried without extra charge; foot passengers, $0.25. No package freight, other than that carried in automobiles and trucks, is handled. The above rates are for one-way service.

During the four seasons that the service has been in operation, its popularity has shown a marked increase from year to year as can be noted from the reports filed weekly with the highway department. In 1918 about 700 vehicles were transported across the Straits during the twelve-months period. By 1922 this total had increased to 9,300 vehicles, service during this five-year period being over privately-operated lines. In the four operating months of 1923, under state operation, the total number of vehicles carried on the one boat then running was 10,480, with a total income for the period of $31,000. In 1924, during the seven months of operation with two boats, the total number carried was 38,468 vehicles, 12,826 foot-passengers, in addition to those carried in vehicles, and a total income of $114,000. In 1925 the vehicular traffic registered 59,321, an increase of 50 per cent over the preceding year. During 1926 the increased rate of transportation was steadily maintained, the number of vehicles carried up to Dec. 3 being 75,125, extra foot-passengers 13,377, total income $202,630.50. The actual number of people carried, in vehicles and foot passengers during this year's season, was about 250,000.

In summarizing the effect upon the public, occasioned by the extension of Michigan's highway system to in-

clude this important marine unit, it is sufficient to state that it has become the most popular service rendered by the State Highway Department. The excellent service, the acceptable rates, and especially the attempt on the part of the department to render a much needed service, have been gratefully received on the part of the people. What it means to the effective strengthening of the relations between the two sections of Michigan through closer intimacy in social and business relations cannot be evaluated. Its importance, financially, may be deduced from the fact that the tourist influx, for which the line is in a great measure responsible, has increased the annual revenue from this source alone to the amount of about $10,000,000.

An article descriptive of the history and operation of Michigan's Marine Highway would not be complete without a statement of credit to those in direct charge of its operation. The fleet is in charge of Senior Captain Anthony May, assisted by Captain Bernard Sloan, both marine men of wide reputation and many years of experience. The administration of the duties of chief purser and steward are entrusted to Clyde Walker. Through these officials the consideration of safety and comfort of the passengers, and efficient and courteous service for the public's convenience, are given constant attention, and their co-operation and efforts to serve for the best interests of the state are in a great measure responsible for the present satisfaction accorded to Michigan's $475,000 investment in its marine transport venture.

Suggested Street Lighting Practice

A specification of street lighting practice for various classes of service has been developed by the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., and is reproduced herewith in tabular form. The spacing of the lamps is segregated into four classes—opposite, staggered, overhead, and on one side of the road only. The uniformity factor which is the ratio of minimum foot-candles to maximum foot-candles well illustrates the different service required of a lighting unit depending on its location. The company states that the first six classes in the table should be lighted with ornamental equipment, the remaining four classes with utilitarian.

MODERN STREET LIGHTING PRACTICE

Class of Street	Height	Spacing	Lumens per Standard or per Unit	Average Horizontal Illumination Foot-Candles	Uniformity Factor Ratio Minimum Foot-Candles to Maximum Foot Candles
1 Main business	18–25	100–140 (Opp.)	20,000–75,000	1.3 –3.0	.75
2 Minor business	15–18	100–150 (Opp.)	10,000–30,000	.8 –1.5	.75
3 Main traffic arteries	15–17	120–160 (Opp.)	6,000–20,000	.5–1.0	.70
4 Minor traffic arteries	14–16	100–140 (Stag.)	4,000–10,000	.2 – .3	.60
5 Residence districts	12–15	110–150 (Stag.)	2,500– 6,000	.1 – .2	.40
6 Park drives	12–15	125–200 (Stag.)	2,500– 4,000	.1 – .15	.35
7 Minor residence districts	18–25	150–200 (O.H.)	2,500– 4,000	.1 – .12	.25
8 Warehouse districts	18–25	150–250 (O.H.)	2,500– 4,000	.08– .12	.25
9 Alleys	18–25	180–250 (O.H.)	2,500– 4,000	.08– .12	.40
10 Highways	25–35	250–350 (O.H.)	2,500	.05– .10	.50

One of a Series of Articles on
OIL FIELD ENGINEERING

Oil Fire Tests Dictate Change in Foam Fighting Methods

Foam Should Be Applied Close to Oil Surface to Be Effective—Portable Foam Mixers Demonstrate Efficiency

THE BURNING of a 55,000-bbl. storage tank half-full of engine distillate in January, 1926, at the El Segundo refinery of the Standard Oil Co. of California, demonstrated an inadequacy of the foam system therein installed although this had always been considered to be first-class. As a result the company instituted an elaborate series of tests to determine what if any improvements could be made. From these tests it was found that the foam instead of being dropped from a considerable distance should be released in a comparatively gentle fashion from near the oil surface.

As equipment for this method, an asbestos tube on the bottom of which was hung a pan-shaped receptacle was developed to be attached to the end of the company's portable foam mixers and to be lowered over the edge of the tank which was on fire. These tubes proved to be so successful that a patent has been applied for but their use will be allowed to other oil companies free of charge. H. H. Hall, chief engineer of the Standard Oil Co. of California, gave a comprehensive report of these tests before the last annual meeting of the American Petroleum Institute at Tulsa, Okla. This report was published in the April *Quarterly* of the National Fire Protection Association and the following information is made available for use here through the courtesies of that association and Mr. Hall.

The tank that burned was modern in every respect having a gastight steel roof, vacuum and pressure valves and an emergency liquid-seal hatch. The tank was being gaged at the time with a steel tape, the resulting explosion blowing the roof from the tank and causing the death of the gager. The foam system was in operation eight minutes after the fire started, the tank being equipped with two foam mixing boxes with special deflectors designed to guide the foam against the shell in its downward journey. One box was injured by the falling roof and the entire capacity of the system was put through the remaining box at a rate of delivery of about 510 gal. of each solution per min. Pumping was continued into this box for 1 hr. and 15 min. at the end of which time enough foam to cover the tank approximately 6 ft. deep had been used (assuming a net expansion of 6) and the fire was still burning fiercely.

For various reasons the portable foam mixers which have been developed by the company's forces, were not applied for several hours, but upon their arrival foam was again applied at the rate of 730 gal. per min., and pumping was kept up for 31 min. With a foam blanket 3½ ft. deep no progress appeared to be made against the fire and it was finally decided to allow it to burn itself out.

Realizing that the conditions prevailing at this fire might occur again at any time, it was decided to make some large-scale experiments to determine why the fire had not been extinguished. The old shell was moved to a more convenient location, straightened as much as possible and re-erected. Independent lines were run to each piece of foam applying equipment with an orifice meter on each line so that information on the rate of flow was always available. Several 80-ft. towers were erected to permit observation of the fire and

thermocouples were located in about fifteen places inside the tank.

The first test practically duplicated the conditions of the actual fire, the foam boxes being about 20 ft. above the oil surface, and although the fire was put out the method of extinguishment was not considered satisfactory.

Observation indicated that foam which is allowed to drop any considerable distance into a fire undergoes the following

FIG. 1—OIL FIRE TEST UNDER WAY
Note observation towers.

losses: (1) A little is dried up as it falls through the heated atmosphere; and (2) a greater quantity is lost when the up-draft of the fire swirls it out of the tank. This swirling is fiercest at the point where the foam is applied, because the falling foam splashes a great deal of oil into the air at that point. When the remaining foam with its high-falling velocity hits the oil surface it is submerged. This submergence no doubt crushes some of the foam bubbles. The

FIG. 2—PORTABLE FOAM MIXERS EQUIPPED WITH ASBESTOS TUBE DISTRIBUTORS

part of the foam that comes up in the fierce burning area is probably consumed by the fire, while another part is forced some distance out under the oil before it comes to the surface. It consequently is covered with an oil film which has to burn off before an effective foam blanket is formed. Thus a very small part of the original foam applied in this fashion ever does effective work.

In the next test it was decided to apply the foam close to the oil surface. A hole was cut in the tank about 3 ft. above the oil level and the mixing chamber was lowered so as to discharge through that hole. Additional holes were cut at about the same elevation so that the portables could also be given an opportunity to operate with only a small drop. In a later test it was demonstrated that these holes could be readily cut after the tank is on fire, thus giving the portable mixers a chance to discharge near the oil surface. As was expected, the foam applied in this way proved far more efficient, although even with this small drop the velocity was sufficient to splash the oil at the point of application.

Further study showed that probably the most efficient plan was to attach to the portable mixers asbestos tubes at the bottom of which could be hung something in the general shape of a dishpan made either of metal or asbestos. It was decided that such an arrangement would protect the foam during its drop, would kill the velocity at the bottom and then release the foam at slow velocity and around a big periphery close to the oil surface. The first tubes failed structurally having been built of wire-inserted asbestos cloth

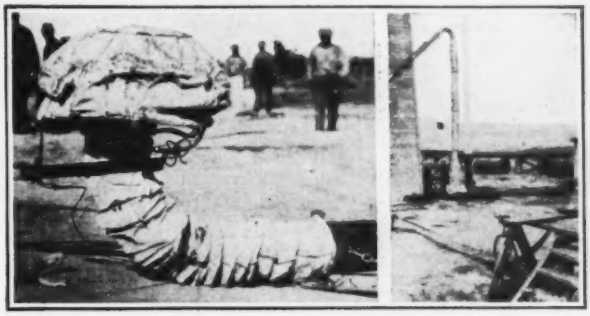


FIG. 3—ASBESTOS TUBE FOAM DISTRIBUTOR
Left view shows it contracted over end of a portable mixer and right view shows it extended.

with no additional reinforcing of any kind. New tubes were designed, well reinforced with wire, and the results were entirely satisfactory. The fire went out under the mixer almost immediately and the foam spread from there crowding the fire ahead of it. Two fires were extinguished with a single portable lowering the foam 20 ft. through the asbestos tube. The rate of application was only about 200 g.p.m. of each solution the first fire requiring a total of about 3,300 gal., and the second 3,700 gal. of each solution, the fire being extinguished in about 20 min. in both cases.

The quantities of foam required for 115-ft. diameter tank were:

Application by dropping	Total Gal. Each Solution
20 ft. from permanent box	34,000
10 ft. from permanent box	11,000
3 ft. from portables without asbestos tube	11,000
3 ft. from permanent box and portables	8,000
20 ft. from portable with asbestos tube	4,000

The efficiency indicated in this table for the portables with the asbestos tube brings up visions of possible future foam systems consisting of mains and hydrants only with possibly smaller solution storage, smaller pumps and a more positive assurance of extinguishing the fire. The portables would be stored in a safe place and would escape the risk of being damaged by the falling roof, etc. The fire in this 115-ft. tank was put out with 3,300 gal. of solution. The company has trucks and trailers working on the roads that carry 6,000 gal. of gasoline and they could just as well carry 6,000 gal. of these solutions. This would mean that there would be one single fire-fighting unit made up of several trucks or combinations of trucks and trailers carrying with them the necessary portables and solutions. Such an outfit might thoroughly protect an area twenty or thirty miles in diameter.

Building Destruction in the St. Louis Tornado

Great Storm on Sept. 29 Sweeps Residence Districts from Southwest to Northeast—Principal Damage to Frame and Combination Buildings—Weak Roof Construction and Anchorage a Factor

By W. J. Knight
Consulting Engineer, St. Louis, Mo.

A TORNADO of terrific force visited St. Louis at 1 p.m. on Thursday, Sept. 29. A small section in the southern part of Webster Groves, a suburb of St. Louis, first felt the destructive force of the storm. The funnel-shaped cloud then lifted and returned to the earth at the southwest corner of Forest Park within the city limits and continued in a general northeastern direction. The path extended west to Kingshighway and east as far as Fifteenth St. in the extreme northern part of the city, and after crossing the Mississippi River continued its destruction on the East Side. The width of the path varies from 300 to 1,000 ft.

The known dead at this writing number 90 persons, although the complete number has not been tabulated. At least 700 to 1,000 persons were injured, but the total of the injured will probably never be known precisely. Approximately 310 city blocks were damaged or destroyed, affecting about 2,600 families. The loss of property, personal effects, stocks, machinery, furnishings, etc., is variously estimated at from $50,000,000 to $100,000,000.

Weather Conditions—From 11:30 a.m. to 12:57 p.m. clouds were noted moving very rapidly from the southwest. One large black cloud seen at 12:57, in particular, appeared to be unusually low. No boiling action was observed. Further cloud observations became impossible because of the high wind and rain. The violent wind

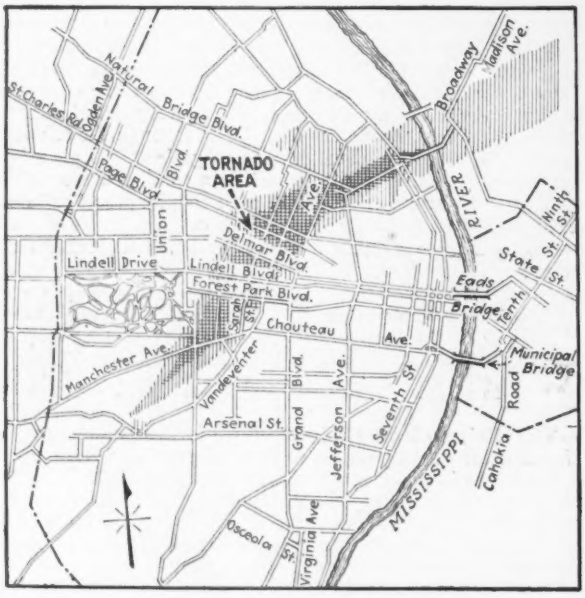


FIG. 1—PATH OF TORNADO THROUGH ST. LOUIS

and downpour of rain occurred simultaneously, resulting in a solid impenetrable grayish brown mass with a blurred effect. Objects outside the windows of the United States Weather Observatory could not be distinguished.

In the five minutes ending at 1:05 p.m. the wind velocity was at the rate of 72 miles per hour. At 1:03 p.m. there was a sudden spurt of 90 miles per hour.

The barometer fell rapidly from 10 a.m. until 1:03 p.m., when there occurred an instantaneous fall of 0.12

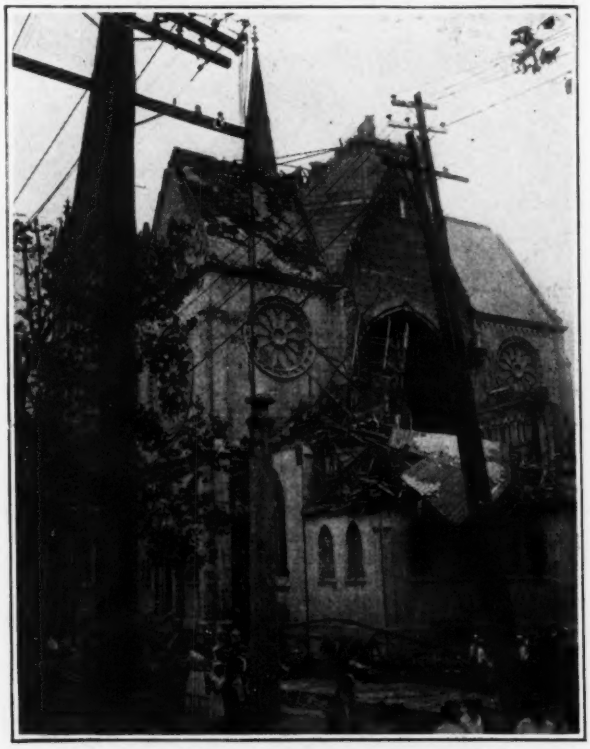


FIG. 2—HOLY TRINITY CHURCH, 14TH AND MALLINCKRODT STS.

in., always a disastrous omen. Shortly thereafter there was an instantaneous rise of 0.22 in. From this time till 6 p.m. there was another uniformly rapid fall. At about 6 p.m. a rise set in and continued through the night.

Destructive Effects—It is impossible at this early writing to give definite figures on the amount of destruction, but the extent of the damage is tremendous. Its character is fairly uniform over the storm path. No major fireproof structures appear to have been damaged.

As usual in such disasters, all building structures of frame and slow-combustion types, including residences, flats, schools, apartments, factories, etc., suffered the greatest destruction. Poor construction was evident in many of the damaged buildings. The face brick of a large building utilized for ice making and storage was in places completely removed, leaving the common-brick backing of the wall intact. Header courses tying in the face brick to the main body of the wall were present, but no mortar existed in the vertical joints. The removal of the face brick may be explained by the expansion of

DAMAGE TO DIFFERENT TYPES OF CITY STRUCTURE IN ST. LOUIS TORNADO OF SEPT. 29

1—Typical street conditions in storm path, Sarah St.
2—Factory building unroofed and torn apart.
3—Store and residence buildings, Sarah and West Belle Sts.
4—Deaconess Hospital, wooden hipped roofs carried away.
5—Brauer Bros. shoe factory, slowburning construction.
6—Polar Wave Ice & Fuel Co., walls blown down.

air in pockets separating the facing from the backing while the low-pressure area of the tornado was passing. Had the vertical joints been filled with mortar instead of air, this damage could not reasonably have occurred.

Many reinforced-concrete structures were located in the path of the storm, but no observations up to this writing have indicated any damage to buildings of this character, except, of course, the inevitable destruction of

windows, plate glass, doors, etc. This damage was particularly noticeable in buildings that were closed tight just prior to and during the storm. Buildings that had doors or windows open to permit sudden exit of air during the passage of storm were by comparison noticeably free from material damage.

The catastrophe demonstrates clearly the hazard and inferior protection offered by slate- and tile-covered roofs when subjected to tornado action. Few roofs of this kind survived the storm. Slate and tile from roofs together with brick and wood are the predominant part of the débris strewn about streets, yards and parks.

Fireproof buildings with wood hipped roofs provided a weak mark for the tornado. A new hospital building on South Kingshighway evidences this conclusion. The wood hipped roof with ornamental tile covering was lifted and completely removed from the north wing and deposited in adjoining sections. The concrete slab under the wood roof prevented disaster to patients in the upper story.

Light non-fireproof steel structures with wood roofs offered little resistance to destruction. It may be stated, with more or less authority, that the destruction of such buildings was due to lightness or want of inertia and lack of anchorage of the constituent parts to resist the lifting action of the storm. The upper part of the grandstand of Sportsman's Park, the National League baseball club's field on North Grand Ave., was designed of light steel trusses with wood roof and tar-paper roofing, the steel frame resting on a concrete structure. A part of this steel roof was lifted from its position and placed, upper side down, almost intact on the street paving below. It is probable that more efficient anchorage of the steel column bases of the superstructure to the concrete frame below would have prevented this collapse. The results of the storm also point to the importance of properly anchoring wood sheathing of roofs to the steel supporting members and adequately connecting the steelwork to the columns.

Some Conclusions—Among the structural lessons and remedies to be learned from the tornado may be listed the following:

1. Slow-combustion types of buildings, including those of all wood frames and floors, or structural steel frames with wood floors and roofs, are inadequate to resist the variable forces of tornadoes. Better anchorage of wood or steel columns at the bases and more effective tying of floor and roof members to the columns, and of roof sheathing to girders and beams, will contribute much toward relieving present prevailing weaknesses, in the event of unusual disasters.

2. It is of prime importance that brick walls be properly laid up with header and stretcher courses, with mortar in all horizontal and vertical joints, to insure structural stiffness, lateral strength and continuity.

3. More effective nailing or anchoring of slate and tile covered roofs is necessary.

4. The hazard occasioned by wood roof superstructures superimposed on fireproof buildings only for architectural purposes is apparent. In hospitals, hotels and places of public gathering, construction of this nature should be eliminated. If roofs of this character persist in the future, all joints and connections should be well tied together, and the purlins, rafters and girders should be effectively anchored to the fireproof frame on which they rest.

The writer is indebted to the United States weather forecaster, Montrose Hayes, for the meteorological data given.

St. Louis Tornado of 1896—It should be recalled that a violent tornado struck St. Louis 31 years ago, on May 27, 1896. That tornado was formed in a huge funnel-shaped cloud, destroying a large section of the southern part of the city and coming also from the southwest. The disaster cost the lives of 350 persons and injured from 1,200 to 3,000. The property loss of 1896, amounting to about $20,000,000, was not as great as that of the recent storm.

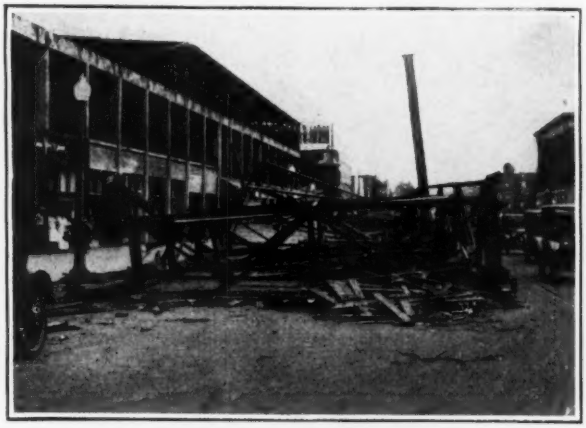


FIG. 3—BASEBALL GRANDSTAND, PART OF STEEL ROOF STRUCTURE BLOWN OFF
St. Louis National League ball park, Grand and Dodier Sts.

The Largest Railway Track Scales

A pair of twin railway track scales of the plate-fulcrum type designed and built by the Pennsylvania R.R. and installed in the freight yards at Altoona, Pa., constitutes the largest plant in existence for weighing carload freight. The scales have a capacity of 800,000 lb. each, but the balances are so sensitive that the weight of a man can be determined within five pounds. Each scale bridge or deck weighs about 73½ tons. The advantage of the plate-fulcrum or flexure plate used in place of the old knife-edge support is that it practically eliminates friction. Heat-treated chrome-vanadium steel is used for the fulcrum plates, which are machined and then finished by grinding, while all surfaces upon which they bear are finished by scraping to exact planes. These scales, located between the receiving and classification yards, weigh all cars while in motion during the process of classification. They have achieved a speed record by weighing an average of five cars per minute, some cars being weighed accurately in five seconds. Both scales, on tracks spaced 14 ft. c. to c., are installed in a single masonry pit, which is well lighted for day and night operation. In winter, the pit is kept at uniform temperature by means of thermostats, in order that the apparatus may not be affected by extreme temperature changes. Since the speed of cars running by gravity is affected by weather and temperature conditions, the summit of each scale track is equipped with a mechanical hump or tilting table (see *Engineering News-Record*, Aug. 14, 1924, p. 260), by means of which the starting grade adjacent to the scale can be varied as required.

News of the Week

Current Events in the Civil Engineering and Contracting Fields

City Engineers of N. Y. State Perfect Strong Association

Reclassification and Schedule of Minimum Compensation to be First Work

SEVENTY-FIVE engineers representing thirty cities and villages in New York State except New York City, gathered in Binghamton Sept. 30 to perfect an organization known as the Association of City Engineers of New York State. This new organization had its inception in the meeting last June of the Conference of Mayors and Other City Officials at Niagara Falls. At a later meeting in Utica the tentative constitution and bylaws were drawn up and officers elected. At the meeting in Binghamton last week these bylaws and constitution were adopted and the society put on a permanent basis.

Though the general purpose of the association is the promotion of mutual welfare in the municipal engineering organizations, the outstanding feature of the day's session was the acknowledgment that something must be done and done quickly to safeguard what municipal engineering organizations have been built up and to make taxpayers recognize the necessity for supplying adequate funds whereby competent engineers can be employed by the cities and villages and held against the more attractive offers of private concerns.

Reclassification Proposed

It is proposed to secure data from city and village engineers as to their needs for specific engineering service and upon that data to base a reclassification of engineers in city employ. At present there are some fifty titles and it is hoped that these can be reclassified into eleven and a salary schedule drawn up for submission during the winter to the Council of Mayors and Other City Officials. A paper setting forth these aims was read by Nelson A. Pitts, city engineer of Syracuse.

Other papers were "Some Aspects of City Planning" by James G. Brennan, city engineer of Albany, and "Financing Highway Improvements" by William P. Capes, secretary of the New York State Bureau of Municipal Information. In his talk, Mr. Capes emphasized the large increase in the past five years of responsibilities placed upon city engineering staffs, due principally to transportation, and made a plea for a share of the gasoline tax for municipal use which he expects to be imposed soon in New York State. Mr. Capes estimated that municipal engineering activities had increased more than 40 per cent in five years.

The advisory committee of the association is a follows: president, Harry R. Hayes, city engineer, Utica; vice-president, Nelson A. Pitts, Jr., city engineer, Syracuse; secretary, Edward H. Prentice, city engineer, Binghamton; C. Arthur Poole, city engineer, Rochester; Christopher J. Sheridan, city engineer, Yonkers; and Earl Harrison, city engineer, Schenectady.

Brief News

Traffic Over Carquinez Bridge Totaled for the 42 days of operation ending Aug. 11, 1927, 171,109 vehicles or an average of 4,074 per day. The toll bridge began operating May 21. The tolls charged are 60 cents for automobiles, and 10 cents for each passenger. Pedestrian commutation is obtainable at $2 per month, and for automobile with driver $17.50 per month.

Construction of a Rail Line between Corpus Christi and San Angelo by way of San Antonio is proposed by the Gulf and West Texas Railroad Co., a newly organized company. The exact location of the proposed road has not been determined definitely.

Experimental Road Work Is Being Done by Canadian Government engineers at Jaspar Park, Alberta, in the utilization of Alberta's bituminous sand for road building and on a section of the heavy traffic road from Edmonton to St. Albert, under the direction of the Advisory Scientific Research Council. The latter is a tryout of a new method of treating gravel with products of the northern tar sands, both the extraction and mixing being done by a process devised by Dr. K. A. Clark, of the University of Alberta research staff.

A Census of Traffic Has Revealed that the bridge across the Hudson River at South Ferry St. connecting Albany and Rensselaer has reached its traffic capacity. The State Department of Public Works has therefore requested the Eastern New York Utilities Corporation to terminate its Albany-Hudson electric lines at Rensselaer instead of Albany and thus provide for additional space for vehicular traffic by the removal of its tracks from the structure. Officials of the utilities company have indicated that the proposal will not meet with their approval. Use of the bridge by the trolley cars of the United Traction Co. was discontinued some time ago with the substitution of complete bus service for Rensselaer.

Baltimore Mayor Ousts Engineers In City Service

Political Changes Result in Dropping Engineering Heads Long with City Departments

ALMOST a complete change in the engineering heads of the Department of Public Works in the City of Baltimore has been made by Mayor Broening in the first list of appointments to be made under his administration. Men of long service with the city—in one case 33 years—have been dropped for no apparent reason other than that their political affiliations were not the same as those of the mayor.

The mayor took office in May of this year. Under the city charter he can make no changes in the department and bureau's chiefs until the first Monday in October. In the past, it has been the practice for the mayor to present to the city council during the latter part of September, a list of appointments to be made, the list being presented at one meeting of the council for action at the following meeting; but in this case the council confirmed all the appointments at the same meeting at which they were presented to them, with the result that the public, and also the deposed office holders, knew nothing of the changes until they had been approved. Thus, the citizens were deprived of an opportunity to protest some of the changes until after the changes had been made.

First Changes in Department

About two years ago a reorganization of the city departments was put into effect by an ordinance which provided that in so far as possible the heads of existing departments would continue in office in corresponding positions. As the reorganization took place at the middle of the term of the preceding mayor, this present change is the first of any importance which has taken place in the engineering department of the city for some years, the department having been fairly free from changes of a purely political nature for many years.

Under the new organization, most of the engineering activities of the city are concentrated in the Department of Public Works under a chief engineer, the separate functions being in bureaus under bureau chiefs, most of whom, the ordinance provides, shall be graduates of engineering schools or men of engineering experience. These positions are all appointive. The lower positions in these bureaus are under the civil service. The following are the appointments made by the mayor effective Oct. 3:

Chief engineer of the Department of Public Works, Charles F. Goob, to succeed Bernard L. Crozier; water engineer, head of the Bureau of Water Supply, Edward G. Rost, to succeed George F. Wieghardt, resigned; highway engineer, head of the Bureau of Highways, Nathan L. Smith to succeed Steuart Purcell, resigned; sewerage engineer, head of the Bureau of Sewers, Milton J. Ruark, reappointed; harbor engineer, head of the Bureau of Harbors, Elmer E. Hammond, to succeed Francis W. McKinney; engineer of street cleaning, head of the bureau, Frank W. Jacoby, to succeed Wm. A. Larkins; engineer of plans and surveys, head of the bureau, Wm. O. Atwood, to succeed Joseph W. Shirley; superintendent of transportation, head of the bureau, Charles W. Pohlman, to succeed Oscar Lackey. Dr. C. Hampson Jones, health commissioner, was reappointed. The mayor did not nominate a head for the Bureau of Mechanical and Electrical Service vice Mr. Goob, nor a head for the bureau of Buildings, Stores, and Standards.

New Engineering Heads

Charles F. Goob, the chief engineer, is an electrical engineer, a member of the A.I.E.E., who came to the city from the engineering department of the Navy in 1919, under a previous administration of Mayor Broening, and has been head of the Bureau of Mechanical-Electrical Service. In the past he has served the city as head of the Highway Department, thus he comes to his new office with a wide experience in the department. Mr. Goob is a graduate of Baltimore Polytechnic Institute and taught there after graduation. Previous to his work with the Navy he was employed in public utility work.

Edward G. Rost, water engineer, has held a minor technical position in the Bureau of Water Supply for about 20 years. He was appointed acting head of the bureau by Mayor Broening upon the resignation of Mr. Wieghardt about a month ago.

Nathan L. Smith, highway engineer, has been assistant highway engineer under Mr. Purcell, and has handled much of the executive work. He is a graduate of Swarthmore College. He also has been acting head of his bureau since Mr. Purcell's resignation in August to become a member of the Public Service Commission.

Elmer E. Hammond, harbor engineer, is a graduate of Maryland Institute. He has been in the employ of the Western Maryland Ry. at Port Covington for the past 15 years.

Frank W. Jacoby is not an engineer. He has served in various capacities with shipbuilding companies. In the case of the head of the Bureau of Street Cleaning, the law says that "if the person appointed as engineer of street cleaning is not a graduate in engineering.....he shall have had less than ten years' experience in charge of large working forces."

William O. Atwood, engineer of plans and surveys, has, in the past, served as city surveyor and commissioner for opening city streets. More recently he has been a member of Congress and state comptroller.

The heads of the bureaus of Transportation, Stores, and Standards are not required to be engineers.

The general impression of the changes as gained in Baltimore is that while made chiefly for political considerations, the mayor has promoted some capable men and retained one or two others. Commenting on the appointments, *The Sun*, Baltimore, says:

> The appointments are good, bad and indifferent. The major post, that of chief engineer, goes to Charles F. Goob, who is well qualified for the duties of the office and should make an acceptable successor to Mr. Crozier, whose record has been excellent. There will be also strong commendation of the appointment of Nathan L. Smith as head of the Bureau of Highways and of Milton J. Ruark, who succeeds himself as head of the Bureau of Sewers. Mr. Ruark is a Democrat, but is generally recognized as being an exceptionally capable and valuable public servant. His retention in service will be widely approved.
>
> Selection of Edward G. Rost to be head of the Bureau of Water Supply, though it retains an official who has been in the department for a considerable length of time and has been its acting head for some weeks, is cause for uneasiness. This department, one of the most important in the City Hall, has supervision and direction of a plant which has cost the people of Baltimore from $60,000,000 to $70,000,000. It will be assumed that Mr. Rost can meet the qualification set forth in the charter for this position. But a municipal activity so closely affecting the health and development of the city, the extension of which from time to time calls for vision and leadership, should be placed in charge only of one who by common consent of the profession with which he is associated measures up fully to its demands. In a less degree the same thing may be said of the choice of Charles W. Pohlman to succeed Oscar F. Lackey as head of the Bureau of Transportation. The public knows Mr. Lackey as a highly efficient engineer and executive. It knows Mr. Pohlman as the Republican executive of the ninth ward.
>
> Joseph W. Shirley has been in the employ of the city for thirty-three years, engaged in work which had to do with city planning. Since the reorganization of municipal departments he has been head of the Bureau of Plans and Surveys. No man in Baltimore knows as much about our street and park plans or has at his command so much information as to their growth and development. He is part of them and every expert invited here to initiate extensions and improvements and every Park Board have found in Major Shirley an invaluable store of knowledge and experience.
>
> The exigencies of politics are frequently responsible for what seems to be excessive brutality in the treatment of public servants. Had Major Shirley's position been given over to some man whose recognized superior fitness for the duties of the office indicated that desire to improve the public service prompted the change, that would have been understandable. But it cannot be contended that the displacement of Major Shirley by William O. Atwood is explainable on this score.

W. W. DeBerard Rejoins Staff of Engineering News-Record

W. W. DeBerard, who has been on leave of absence for a year, has rejoined the editorial staff of *Engineering News-Record*. Mr. DeBerard, who has been in technical journalism since April, 1910, when he became western editor of *Engineering Record*, was granted a leave of absence Aug. 1, 1926, to become chief engineer of the Chicago Regional Planning Association. During the past year he was largely responsible for the development of Cook County's $15,000,000 highway bond issue program and for the detailed program of road construction on which that bond issue was based. By his direction similar programs of road construction have been carried forward and new ones initiated in the territory surrounding Cook County. Of his work Robert Kingery, secretary of the planning association, has this to say:

"Through Mr. DeBerard's efforts also considerable basic work has been done with the various sanitary and conservancy districts in the region of Chicago and a fine foundation has been laid, through his familiarity with the subject, for future work by regional plan in ending pollution of Lake Michigan and of the streams of the region."

When a leave of absence was granted Mr. DeBerard was western editor of *Engineering News-Record*.

R. R. and Utilities Commissioners to Meet at Dallas, Texas

The 39th annual convention of the National Association of Railroad and Utilities Commissioners is to be held at Dallas, Tex., Oct. 18-21. The meeting is expected to be unusually important as the regulation of motor vehicle lines, especially lines engaged in interstate operation, is to be the subject of an entire session. This matter is expected to come up before Congress for legislative action this winter and the Interstate Commerce Commission is preparing a report on the subject for submission to Congress. Among other subjects to be discussed are railroad valuation, grade crossings, water power, and holding companies.

Sacramento Water Supply Bond Issue Defeated

The proposal to issue $11,600,000 in bonds for the construction of the so-called Silver Creek water and power project by the city of Sacramento, Calif., was defeated on Sept. 27. The proposal received a majority vote but less than the two-thirds required by law; 8,701 votes were cast for the bonds and 6,786 against them. The plan was to develop a mountain water supply for the Sacramento Municipal Utility District. It was opposed by those who were not in favor of having the municipality go into the power business.

Eastern Builders Guests of Super Cement Company on Inspection of Detroit

Thirty engineers, architects and contractors from New York, Philadelphia, Boston and other eastern cities, spent Sept. 28 and 29 in Detroit inspecting concrete construction in which "Super Cement" had been or is now being used. Albert Moyer, president of the Vulcanite Portland Cement Co., was host to the party.

This special cement is made particularly colloidal by the addition of minute quantities of tannic acid introduced through the medium of gypsum. Its field has been confined largely to underground structures—waterproofing service and making dense concrete to resist the disintegrating action of sulphate waters encountered in deep caisson work in Detroit. Few if any caissons have been sunk to bedrock in Detroit until this construction season. Two notable examples claimed the attention of the inspecting party.

1. The Penobscot Building, which will be the tallest structure in the city (575 ft.), will load the 6-ft. 9-in. piers with 5,000,000 lb. each. A 12-ft. stratum of hardpan on top of a seamed limestone bedrock 132 ft. below ground level has been the usual foundation for Detroit buildings. In this building it was thought necessary to go through the hardpan to rock because of the high caisson loading. The caissons were sunk through the overlying stiff blue clay by the Chicago method of open excavation followed by the setting of stave lagging held by interior hoops. As the first caisson broke through the hardpan a rush of sulphur-bearing water came in, making it necessary to put on compressed air to control the water. Because of the danger of subsequent deterioration of the concrete due to the sulphate water, the special cement was used to fill the caissons.

2. The Delray plant of the Detroit Edison Co. was the second bedrock caisson job, (described in *Engineering News-Record* Sept. 21, page 424). The lower half of the caissons was filled with concrete made more dense by the use of Super Cement with the idea of doing everything possible to insure the integrity of the foundation piers, which must carry as a maximum 3,000,000 lb. each.

Since the demonstration of these two jobs that caissons can be set on bedrock in Detroit, several buildings of extraordinary height have been planned and architects predict bedrock will hereafter be the foundation of all heavier structures.

Among the tunnel jobs inspected, all of which are in areas of high groundwater, were the following: (1) A ¾-mile tunnel carrying steam and service lines from the power house of the University of Detroit all over the campus; (2) a tunnel installed 28 ft. underground in quicksand for steam and other conduit lines between the Fisher Body Corporation Pontiac plant, and the General Motors plant building the automobiles. Both tunnels were found bottle-tight.

Power plant pits, roads and stucco work were also included in the itinerary of inspection.

E. W. Reed-Lewis, superintending engineer the Super Cement Co., which has licensed five cement companies to make the product, emphasized that the cement is a waterproofing agent primarily. It is distinctly not a quick-setting cement. In fact, it shows no initial set, he stated. It is not inherently stronger than normal portland except as the better workability induced by the fatter or more colloidal property may make an equal amount of mixing more effective.

High Dam for Flood Control on San Gabriel River

Plans for the dam which the Los Angeles Flood Control District plans to build in the San Gabriel Canyon have been switched from the originally proposed "high dam" to the "low dam" and back again. The high dam would store 240,000 acre-ft. and the low dam, 180,000 acre-ft. Present plans, according to an announcement made by counsel for the board of supervisors at a court hearing on Sept. 21, are to proceed with the construction of the high dam.

Objection was raised to the original plans prepared by the Flood Control District for a high dam and a board consisting of Messrs. Marx, Fowler and Paul made a report (see *Engineering News-Record*, Apr. 7, 1927, p. 570), pointing out that the high dam was not justified. Plans and specifications were then revised by the Flood Control District and bids were received on the low dam after which suit was brought by certain tax payers to compel a return to plan for the high dam. Hearings were held and writs were issued by both the California State Supreme Court and the Appellate Court, both favoring those litigants who wanted the high dam.

At the hearing on Sept. 21 before the Second District Court of Appeals counsel for the petitioners urged the issue of a permanent writ compelling the construction of the high dam so as to prevent the supervisors from reverting to plans for a low dam. The court refused this petition and held that a permanent writ of mandate could not be issued because it would cease to compel an act already partially accomplished and one which the defendant is ready to do without coercion.

Germany to Hold Conference on Engineering Materials

Plans are well under way for the conference on engineering materials to be held from Oct. 22 to Nov. 12, at the Technical University in Charlottenburg, Germany. The program contains some 200 papers. Three groups of engineering materials will be considered: Iron and steel, non-ferrous metals, and electrical insulation materials.

Wire Cables Lower Than Eyebars in Bidding on Ft. Lee Suspension Span

Bids received by the Port of New York Authority, Oct. 2, for the steel superstructure for the Hudson River bridge between Fort Lee and Manhattan showed a range from $22,474,417 to $25,962,020 with the wire cable and eyebar cable designs in direct competition for the first time in work of great magnitude. Wire cable bids were generally lower than those for the eyebar design. The lowest combination was formed through the wire cable bid of John A. Roebling Sons, Co. of Trenton, New Jersey, and the McClintic-Marshall Co., whose figures totalled $22,474,417. The Roebling cable bid alone was $12,339,977 and the McClintic-Marshall bid for the steel towers and floor was $10,134,440. A combination of the Roebling cable bid with the steel bid of the American Bridge Co. totaled $22,645,197; and a combination of the McClintic-Marshall Co. and the American Cable Co., also a wire cable proposition, amounted to $22,817,608.18.

In order to increase competition bids were received upon the cables alone and others upon the steelwork alone. A third method followed was the receipt of bids upon the cables and steelwork as one contract. Besides the three combinations already mentioned the tabulation showed the following proposals:

Bethlehem Steel Co., towers and floor, and John A. Roebling Sons Co., wire cable, $22,960,997; American Bridge Co., towers and floor, and American Cable Co., wire cable, $22,988,318.18; McClintic-Marshall Co., steelwork and wire cable, $23,026,620; Bethlehem Steel Co., towers and floor, and American Cable Co., wire cables, $23,304,188.18; American Bridge Co., steelwork and eyebars, $24,485,370; McClintic-Marshall Co., towers and floor, and American Bridge Co., eyebars, $24,625,645; American Bridge Co., steelwork and wire cables, $24,670,800; McClintic-Marshall Co., towers and floor, and American Bridge Co., wire cables, $25,103,895; Bethlehem Steel Co., towers and floor, and American Bridge Co., eyebars, $25,129,275; Bethlehem Steel Co., towers and floor, and American Bridge Co., wire cables, $25,590,475; McClintic-Marshall Co., steelwork and eyebars, $25,962,020.

Construction of 95-Mile Railway Into Texas Approved

Construction by the Clinton & Oklahoma Western R.R. Co. and its subsidiary, the Clinton-Oklahoma-Western R.R. Co. of Texas, of a line from its present terminus at Cheyenne, Okla., to Pampa, Texas, a distance of approximately 95 miles, has been approved by the Interstate Commerce Commission. The estimated cost of construction is $2,025,202 including $70,000 for equipment. Construction is to be commenced before May 1, 1928, and completed before June 30, 1929.

The construction of this line was opposed by the Santa Fe as diverting traffic from its lines.

Accident Prevention Manual Aims to Promote Safety in The Construction Industry

What is regarded as the longest single step ever made toward promotion of safety in the construction industry has just been taken by the Associated General Contractors of America through the issuance of that organization's Manual of Accident Prevention in Construction. The manual is being distributed among general contractors in all sections of the country as a part of the accident prevention campaign launched intensively this year by the contractors' national organization.

In the preface to the manual, W. F. Austin, president of the W. E. Wood Company, Detroit, and chairman of the committee on accident prevention of the A.G.C., says in part:

"Information on accident prevention is very limited, although a number of books on accident prevention have appeared since the safety movement became a vital force in industrial safety work. The future progress of the accident prevention movement, the decision whether it shall advance with sufficient speed and strength to reduce the apparent increase of accidents in construction for which mass production and mechanical methods are largely responsible, rests with the general contractors of the United States. It is for them that this manual has been written."

The table of contents of the manual discloses the following as titles of individual chapters: Public Demand for Safety; Voluntary vs. Mandatory Accident Prevention Effort; What is an Accident; Hidden Losses; Character of Accidents; Picture of Construction Operations; Greensfelder's Ten Cardinal Points; Extracts from Seth Sieder's "Constructive Talks to Pivot Men"; Extracts from National Safety Council Literature; Relation of Production to Accidents; Insurance and Rates; Estimated Savings; Character of Construction Executives; Character of Building Labor; Scheme of Organization; General Statement; Group Plan; Accident Prevention Committees; Safe Practice Rules; First-Aid Classes; Statistics; Meetings; Bulletins; Board of Inquiry; Danger Signs; Co-operation with Other Agencies; Individual Plan.

The contractors' association is carrying on its accident prevention campaign under finances provided by the W. E. Wood Memorial Fund, established early in 1927 as a memorial to W. E. Wood, organizer and president of the W. E. Wood Construction Company, Detroit, who lost his life three years ago as a result of an accident. Many individual contractors, as well as branches and chapters of the association, have made contributions to this fund during recent months.

A series of visits to construction centers in all parts of the country is now being made by W. R. Richards, member of the Washington staff of the A.G.C., who is in immediate charge of the accident prevention activities.

Building Trades Quit Board of Jurisdictional Disputes

Maintaining that it was the only one of five national organizations to carry out the decisions of the National Board for Jurisdictional Disputes the Building Trades Department of the American Federation of Labor has withdrawn from that body, according to press dispatches from Los Angeles where the A.F.L. is in session.

The Building Trades Department of the A.F.L., which is spokesman for 1,250,000 building trades workers, has by its action imperilled the life of the board established eight years ago for settling jurisdictional disputes between unions. These disputes had cost the public millions of dollars, resulting in scores of strikes and delays in construction. Attacks on the national board, whose president is Rudolph P. Miller of New York, were made by the bricklayers, the carpenters, the elevator constructors and the electrical workers.

It was further asserted, in the resolution of withdrawal, that the national board made insistent rulings, that it did not enforce its rulings, that certain members of the board were prejudiced against some unions, that the board has frequently reversed itself and that the decisions of the board have been unfair.

The building trades departments agreed to abide by the rulings of the board at the Atlantic City convention in 1919. Thereafter the board settled about 200 jurisdictional disputes. The carpenters, with a membership of about 350,000 withdrew from the building trades department at the Denver convention in 1921 because the board awarded the work of handling metal doors and trim to the sheet metal workers by default as the carpenters had not presented their case to the board, and the Building Trades Department had ruled that all unions must abide by the board's awards.

Coincidentally with the adoption of the resolution of withdrawal the carpenters applied for re-admission to the building trades department and were admitted.

Deep Channel Widening in Lower Hudson Subject of Hearing

The River and Harbor Act approved Jan. 21, 1927, directed that a preliminary examination be made of the Hudson River channel, New York, from the Battery to 20th St. with a view to securing a depth of 40 ft. from shore to shore.

A public hearing on the subject will be held by the U. S. District Engineer in the Army Building, 39 Whitehall St., New York City, at 10 a.m. Friday, Oct. 14. All interested parties are invited to be present or to be represented, particularly navigation interests and the officials of any county, city, town, or local association whose interests may be affected by the proposed improvement. They will be given an opportunity to express their views.

Civil Service Examiner Recommends Higher Pay for N. Y. City Engineers

A summary report recommending reclassification of engineers, draftsmen, architects and other technical men in the city employ, carrying with it an increase of about 35 per cent in annual salaries, has been submitted by the chief examiner to the Municipal Civil Service Commission of New York City.

The report, made by Thomas H. Murray, and which followed almost a year of study of the salary situation in connection with technical employees, meets with the approval of the three organizations in which city engineers and technical men are members. They are the Association of Engineers of New York, the Union of Technical Men, Local 37, and the Society of Municipal Engineers.

The Murray recommendation would make the minimum entrance salary $2,160 for the first grade, instead of $1,560 as it is now, with a maximum for that grade of $2,880. Automatic increases of $180 a year, instead of recommended ones, also are proposed. The second grade would have a minimum of $3,120, yearly increase of $240 and maximum of $4,080, instead of $2,760 to $3,300.

In the next grade the salaries would be $4,260 to $5,460, instead of $3,300 to $4,200, and the final grading lists a minimum of $6,000, in place of $4,500, with increases to be decided by the Board of Estimate.

Mr. Murray declares in his report that as long ago as December, 1926, he believed "it was a matter of common knowledge that the present salary schedules are generally unsatisfactory." He attributes those schedules to the policy of the Municipal Civil Service Commission of allowing a rate to stand if sufficient applicants accepted service at that rate.

He finds, however, that there is not sufficient attraction for efficient technical men in the salaries offered and that those who do accept leave for higher remuneration in private employ.

"The actual purchasing power of the compensation offered is no greater than that paid for similar work before the war," is his conclusion.

Chicago Stops Readings of Small Meters

The commissioner of public works of Chicago, under order from the mayor, has directed the water bureau to cease the reading of meters in residence and apartment buildings where the annual water bills are less than $40. This order restores the old system of payment by length of frontage and number of fixtures in buildings of this class. At the same time, the commissioner has ordered the installation of a number of meters on services to large consumers. The former step is reported as in line with the mayor's campaign promises for the non-metering of small consumers.

Moffat Tunnel Progress

The full size railroad section of the Moffat Tunnel was 96.6 per cent complete on Sept. 15, there remaining only 1,091 ft. of enlargement and 109 ft. of widening to be timbered. The headings for the parallel pioneer tunnel were holed through on Feb. 18, and those of the main tunnel on July 13, 1927.

Engineering Societies

Calendar

Annual Meetings

CONFERENCE OF STATE SANITARY ENGINEERS, Washington, D. C.; Meeting with American Public Health Association, Cincinnati, Ohio, Oct. 17, 1927.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Fall Meeting, Columbus, Ohio, Oct. 12-14, 1927.

ASSOCIATED GENERAL CONTRACTORS, Washington, D. C.; Fall meeting, Birmingham, Ala., Oct. 17-19, 1927.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION, Chicago, Ill.; Annual Meeting, Minneapolis, Minn., Oct. 18-20, 1927.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, St. Louis, Mo.; Annual Meeting, Dallas, Texas, Nov. 14-18, 1927.

ASPHALT PAVING CONFERENCE: Under the auspices of the Asphalt Association and Association of Asphalt Paving Technologists; annual conference Atlanta, Ga., Nov. 28-Dec. 2, 1927.

HIGHWAY RESEARCH BOARD, NATIONAL RESEARCH COUNCIL, Washington, D. C.; Annual meeting, Washington, D. C., Dec. 1 and 2, 1927.

THE BOSTON SOCIETY OF CIVIL ENGINEERS at its opening meeting of the season Sept. 28 had as features on the program the presentation of moving pictures showing the entire cycle in the production of electricity in the hydro-electric development at Conowingo, Md., by Albert A. Northrop, of Stone & Webster, Inc., and slides showing design features of the dam, gates, waterwheels, etc., presented by Harry A. Hageman, chief hydraulic engineer of Stone & Webster, Inc.

THE CENTRAL STATES SECTION of the American Water Works Association at its annual meeting Sept. 15 and 16 at Akron, Ohio, elected the following officers: President, Mentor Hetzer, Moundsville, W. Va.; vice-president, D. C. Grobbel, Detroit, Mich. The secretary-treasurer will be appointed by these two officers and the three trustees of the society.

THE INTERNATIONAL CITY MANAGERS ASSOCIATION, at its annual meeting held at Dubuque, Iowa, Sept. 13 to 15, included the following subjects in its program: "Street Widening and Traffic Problems," O. E. Carr, Fort Worth, Tex.; "City Manager Problems in a Small City," F. R. Buechner, Gladstone, Mich.; "The Technique of City Management," R. W. Rigsby, Durham, N. C.; "Recent Developments in City Planning," George B. Ford, New York; "City Management and Industry," John D. Clark, Midwest Refining Co., Denver, Colo.; "Building Codes," Clarence Goldsmith, Underwriters' Laboratory, Chicago; "Training for the Profession," Dr. A. R. Hatton, Northwestern University, Evanston, Ill. Officers elected are: President, John N. Edy, Berkeley, Calif.; vice-presidents, F. R. Buechner, Gladstone, Mich.; O. A. Kratz, Astoria, Ore.; W. P. Hunter, Roanoke, Va. The executive secretary (re-elected) is John G. Stutz, Lawrence, Kan.

AMERICAN ENGINEERING COUNCIL Administrative Board will meet at York, Pa., Oct. 20 and 21. The president of the council, Dexter S. Kimball, dean of the College of Engineering, Cornell University, will preside.

THE SOCIETY OF TERMINAL ENGINEERS (headquarters 30 Church St., New York City) will hold its next regular meeting Oct. 11 at 29 West 39th St., New York City. An illustrated address, "Experiences of a Terminal Engineer in the Orient," will be given by Paul P. Whitman, president, Asia Development Co., Shanghai, China. Mr. Whitman recently returned from the Orient after ten years' connection with the development of China's major ports and terminals as a special commissioner of the U. S. Government, to report on port and transportation developments in the Far East, and as the American member of the International Advisory Board at the Port of Shanghai.

Personal Notes

JACOB S. LANGTHORN has been elected second vice-president of the George A. Snedden Co., Builders, New York City, and will be in charge of its sales department.

ROY A. KLEIN has been reappointed chief engineer of the Oregon State Highway Commission.

D. M. SINCLAIR, for the past three years connected with road design and construction for Linn County, Iowa, and previously with the Wyoming North & South R.R. at Sheridan, Wyo., has joined the sales promotion department of the Celite Products Co. at Los Angeles, Calif.

MAJOR JOHN W. N. SCHULZ, of the U. S. Engineers Corps, district engineer in San Francisco, Calif., during the past three years, has been transferred to Camp Lewis, Washington.

PROF. S. S. STEINBERG, head of the department of civil engineering at the University of Maryland, has resigned as assistant director of the Highway Research Board, National Research Council, in order to return to his duties at the University and to practice as consulting engineer on road and street construction. His offices will be at College Park, Md.

W. CHASE THOMSON, Montreal, Que., having completed his engagement with the Department of Railways and Canals, as bridge and structural engineer to the Canadian Section of the Joint Board of Engineers, serving on the St. Lawrence Waterway project, has accepted a position on the engineering staff of the Dominion Bridge Co., Ltd., Montreal.

GUY G. HARVEY, who has been district engineer of the highway district in which Spokane, Wash., is situated, has been superseded by George H. Shearer, appointed by the state highway engineer, effective Sept. 1. Mr. Shearer has been resident engineer on construction of Snake River and Columbia River ferry bridges, and since May 1 served as assistant office engineer in the state highway department.

LINCOLN E. WILKES, Hillsboro, Ore., cadastral engineer for the United States government, retired at the end of August after many years' service. Mr. Wilkes has surveyed new regions in the Pacific states and Montana, Idaho and Arizona, and islands in the Pacific, some of the surveys being difficult work in these islands and on mountain streams. He will reside at Hillsboro.

JOHN N. MACKALL, chief engineer and chairman of the Maryland State Roads Commission, has been appointed by Governor Albert C. Ritchie as a member of a commission which will make a general investigation of automobile accidents and losses and report to the next session of the Maryland General Assembly.

CLAUDE JOHNSTON, resident engineer for Anglin-Norcross, Ltd., contractors, Montreal, who supervised the construction of the new wing of the Chateau Frontenac, in Quebec, has resigned to accept the position of chief engineer of construction for the Adelard Deslauriers Co., Ltd., Quebec.

ERIC H. EWERTZ, past president of the American Welding Society and formerly general manager of the Bethlehem Shipbuilding Corporation, has opened an office at 50 Church St., New York City, as a consulting engineer on problems relating to welding, mechanical and economic engineering.

G. H. WILSEY, formerly chief engineer of the St. Paul Union Depot Co., has joined the organization of Foley Brothers, Inc., general contractors, St. Paul, Minn. He will be located in the New York office of the company as engineer and superintendent. At present Mr. Wilsey has charge for the firm of the excavation for the approach and anchorage of the Hudson River bridge at Fort Lee, N. J., where a large crushing plant is being built to crush the trap rock removed from the Palisades.

W. A. JONES, who has been in engineering and surveying practice at Columbus, N. C., has been appointed a resident engineer on highway construction for the South Carolina State Highway Department and is located at Dillon, S. C.

Construction Equipment and Materials

A Section Devoted to What the Manufacturer Is Doing for the Engineer and Contractor

Lumber Manufacturers Start Extension Campaign

The National Lumber Manufacturers Association, composed of some 300 of the soft wood and hardwood manufacturers' distributors in the United States and British Columbia, has subscribed $1,000,000 a year for five years for a united drive in the interests of lumber in competition with other building materials. Co-operation between the manufacturers of different kinds of lumber is based on the belief that the rivals of lumber compete with it as lumber and not as varieties of lumber.

The campaign is also said to include scientific research bearing on reforestation and the employment of hitherto neglected species of trees, economical utilization, and such problems as the prevention of decay and the rendering of wood fireproof or fire resistant. Research work is also planned to extend into the manufacturing and merchandising fields. An extensive advertising program is now introducing the trade extension endeavors.

Reinforcing Steel Handbook Soon to be Available

In his presidential address delivered at the semi-annual meeting of the Concrete Reinforcing Steel Institute at the Aviation Country Club near Detroit, on Sept. 19, George E. Routh, Jr., reviewed the accomplishments of the institute since its meeting last March. Among the most important of these has been the creation of a handbook for the reinforcing steel industry, which, according to Mr. Routh, is now in the printers' hands. The handbook contains the following: A code of standard practice; specifications for placing steel; specifications for reinforced concrete; standard steel and cement specifications; and design data. It is felt that the members of the institute will profit greatly by this handbook, which was primarily published to make design in reinforced concrete easier for the less experienced engineers.

Business Notes

WESTINGHOUSE ELECTRIC & MFG. Co., East Pittsburgh, Pa., announces promotion of R. L. Wilson, works manager of the East Pittsburgh plant, to assistant to vice-president and general manager; and of J. M. Hipple, manager, motor engineering department, to the position of works manager. Mr. Wilson joined the Westinghouse company in 1893 and Mr. Hipple in 1898. Mr. Wilson during the time before he became works manager was prominently connected with the company's railway work. He handled the electrification of the New York, New Haven & Hartford R.R., and also the electrification of the St. Clair Tunnel, Detroit, as well as the Interborough Rapid Transit Work in New York City. Mr. Hipple has been in charge of designing for all industrial apparatus during his service since 1911 as manager of the motor engineering department.

BROWN HOISTING MACHINERY Co., Cleveland, and INDUSTRIAL WORKS, Bay City, Mich., have held stockholders' meetings at which plans for the consolidation of the two companies were approved. The merger was effective about Oct. 1. The name of the new company is Industrial Brownhoist Corp. The company is organized under the laws of Ohio with general offices at Cleveland. Alexander C. Brown is president of the new company.

THE COFFIN VALVE Co., Boston, Mass., announces the appointment of the Chapman Valve Manufacturing Co. as its exclusive sales agents in the United States, Canada, Mexico and Cuba, for the sale of sluice gates, shear gates, tide flap valves, and similar equipment.

RICHARD DEVENS, for the past 22 years manager, New York office Brown Hoisting Machinery Co. has resigned, effective Oct. 1. No announcement has been made of Mr. Devens' future plans.

HARRY BUFFINGTON, who has been appointed chief engineer of the Baker Manufacturing Co., Springfield, Ill., has had a wide experience in shop practice and machine design with the International Harvester Co. and the Minneapolis Steel & Machinery Co. He was for several years chief engineer of the Holt Manufacturing Co., Peoria, Ill., and up to the time of this most recent connection was chief engineer of the Weaver Manufacturing Co., Springfield, Ill., makers of garage equipment.

NEW ENGLAND WOOD PRESERVING Co., Boston, Mass., has been made eastern sales agent for the new wood preserving plant of J. F. Prettyman & Sons, Charleston, S. C.

NATIONAL LUMBER MANUFACTURERS ASSOCIATION, Washington, D. C., announces the appointment of Arthur T. Upson as director of the eastern division of its Lumber Trade Extension Department, with headquarters in New York City. Mr. Upson has been in charge of the National Association's standardization work and will continue this as well as serving as secretary of the central committee on lumber standards.

DAYTON-DOWD Co., Quincy, Ill., has appointed Robert L. Eltringham representative for the sale of its pumps in northern California with offices in the Pacific Gas & Electric Building, San Francisco. In the Pittsburgh district, W. L. Vansant and Stuart Goldsborough, Farmers Bank Building, will handle the sale of the company's pumps.

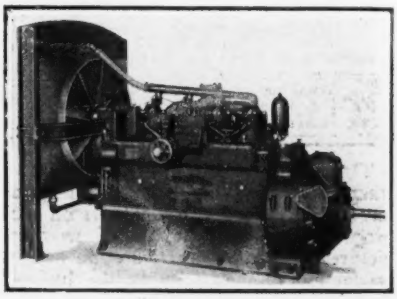
N. R. CRAWFORD, for several years director of sales, Industrial Works, Bay City, Mich., has resigned, effective Oct. 1. No announcement has been made as to his future connection.

CHAIN BELT Co., Milwaukee, has appointed Luther H. Bosnian superintendent of its Park Street plant.

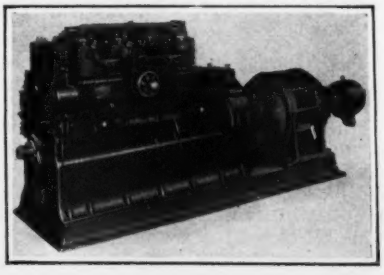
New Developments

Light Weight, High Speed Diesel Engine Developed

During the past few years a number of high speed light weight Diesel engines have been brought out which more and more place the Diesel engine on a competitive basis with gasoline engines in similar sizes. Fairbanks, Morse &



Co., Chicago, has developed such a line of Diesels in ratings from 30 to 180 hp. Such engines may be built with modifications. They may be equipped with a radiator and with a built-in clutch of the automobile type for such applications as dredges, power shovels, and locomotive cranes. They may also be equipped with a pulley and used for conveyor drives or for any other application where it is desired to use a belt drive. The speed of these Diesels is approximately the same as that required for centrifugals or screw pumps; it is possible to

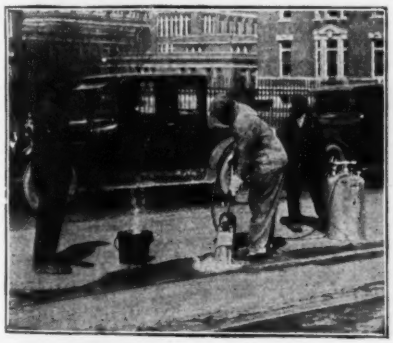


direct connect them to this type of equipment. Still another application is the direct connection of a small a.c. generator with direct connected exciter. It is claimed that with this line of Diesels there are for the first time made available Diesel engine a.c. generator sets as small as 36 kw.

If desired, these engines may be equipped with a ball bearing direct current generator. The resulting unit is said to be very compact, a 40-kw. generating set requiring a floor space of only 2 ft. 9 in. by 8 ft. 1⅛ in. The new Diesels are equipped with both manual and governor control. The engines are started with compressed air at a pressure of about 250 lb. per sq.in., which is supplied by a small air compressor and stored in small tanks.

Torch-Type Oil Burners Have Many Uses

Portable oil burners, such as the one shown in the accompanying illustration, recently placed on the market by Littleford Bros., Cincinnati, Ohio, are being used for a number of purposes. The illustration shows them being used to dry holes in one of Cincinnati's principal streets before asphalt patching. They have also been found adaptable for concrete heating, heating mortar in cold weather, thawing frozen piles of sand, gravel, coal, coke, stone, etc., heating asphalt in melting kettles, drying concrete tunnels and subways for waterproofing, thawing frozen ground before



excavating, melting ice and snow off street manhole covers, and for thawing frozen hoppers of coal cars and frozen railroad switches, and for other similar work.

Process Makes Tracings from Old Blueprints

By means of a photographic process recently developed by J. R. Shays, Jr., 100 Greenwich St., New York City, it is possible to reproduce a drawing on tracing cloth from an original tracing, a good clear blueprint, a printed page or the original drawing. The reproduction may be made to the same scale as the original or on a scale either enlarged or reduced. Another application of the process permits the consolidation of two different scale drawings on one tracing, the one brought up to the scale of the other. One advantage pointed out for the process is that intricate drawings can be made to a large and convenient scale and then reduced to mailing and filing size.

A special film is used, permitting finished tracings or Shays prints to be made as large as 40x60 in. in one piece. Originals up to 48x72 inches can be conveniently handled, and larger originals can be handled in sections. In the process, either a negative or a positive film is made, depending on the desired results. From a positive film, a special blueprint transfer is made, the copy being placed on a gelatine plate and a litho-tracing made. By the same method black line lithos on paper or cloth are possible. In the other process, the negative film is placed in a vacuum frame with a tracing cloth upon which the image is printed directly. This tracing has been previously waterproofed and sensitized and acts similarly to photographic paper. After exposure it is washed, developed and fixed and is ready for immediate use. This method has the advantage in being quicker than the litho method.

New Pull Shovel Features Control of Dipper Angle

A new type of pull shovel or trench hoe has recently been introduced by the Thew Shovel Co., Lorain, Ohio, which is designated as a "back digger." The primary difference between this and previous types is in the control of the dipper, which can be tilted by the operator to any angle desired, at any stage of the digging or dumping operation. Instead of spilling the dipper load through the entire arc of the digging arm, this tilting dipper permits the operator to hold his load until it is spotted exactly over the truck or spoil pile. This tilting feature is also advantageous when excavating sticky material which requires a shaking of the dipper. Unusual digging advantages are also claimed. Another use is pointed out in connection with backfilling work. The dipper can be pulled to the edge of the trench in a horizontal position, pushing the dirt before it, and can then

be tilted to empty the dipper into the trench. This equipment can be attached to any of the company's Lorain-75 or Lorain-60 shovels.

Manufacturers and Trade Associations

Calendar

Annual Meetings

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, New York; Annual convention, Pinehurst, N. C., Oct. 25-29.

NATIONAL ASSOCIATION OF MANUFACTURERS; Annual meeting, Chattanooga, Tenn., October 25, 26 and 27.

NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING. Sixth Annual Show. New York City, Dec. 5-10.

NATIONAL SAND AND GRAVEL ASSOCIATION, Washington, D. C.; Annual Convention, Detroit, Jan. 4-6, 1928.

ASSOCIATED EQUIPMENT DISTRIBUTORS, Milwaukee; Annual meeting, Cleveland, Jan. 6-7, 1928.

AMERICAN ROAD BUILDERS ASSOCIATION, Washington, D. C.; Annual Convention, Cleveland, Ohio, Jan. 9-14, 1928.

NATIONAL CRUSHED STONE ASSOCIATION, Washington, D. C.; Annual Convention, West Baden, Ind., Jan. 16-19, 1928.

New Publications

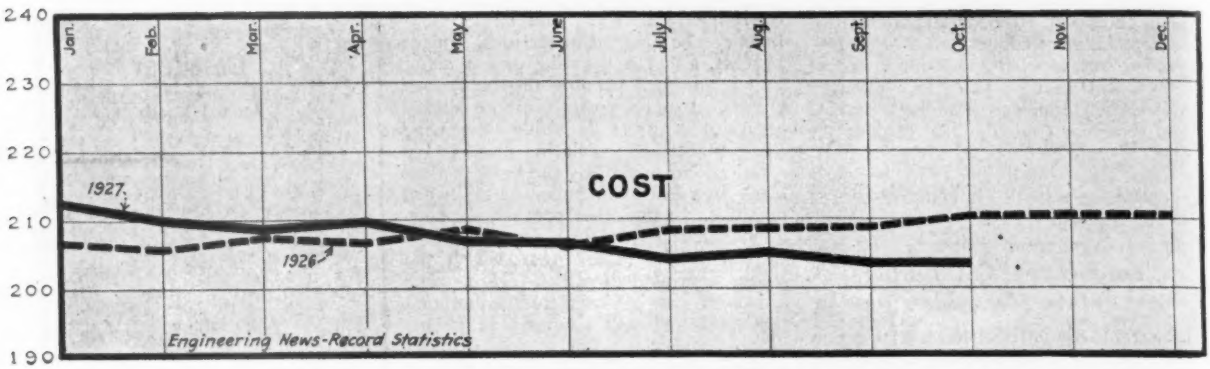
Pipe Jointing Material—HYDRAULIC DEVELOPMENT CO., Boston, devotes its sixteen page catalog No. 50 to its product, Lead-Hydro-Tite, and to its use in jointing water mains. The catalog contains instructions for making the joints and in addition illustrates and describes the melting pots, furnaces, and other necessary accessory equipment. Extracts from letters of many users of the material are included in the catalog.

Better Construction Bulletin—SOUTHERN PINE ASSOCIATION, New Orleans, La., has published a booklet, entitled "Creating and Supplying the Demand for Better Construction," which tells the story of its efforts to interest the public in more substantial building by such means as erecting model homes and giving demonstrations to explain important points of sound construction.

Concrete Reference Tables—NORTH AMERICAN CEMENT CORPORATION, New York City has made available, for hanging on the walls of engineers' and contractors' offices, a card containing reference tables for concrete work such as recommended mixes, water cement ratios, material required for 1 cu.yd. of concrete, materials required for 100 sq.ft. of walls, floors, etc., and materials required for mortar work. The wall board is copyrighted by the North American Cement Corp.

Engineering News-Record Statistics of the Construction Industry

October 6, 1927 — *in the United States* — Vol.99, No.14



Engineering News-Record CONSTRUCTION COST Index Number (1913 = 100)

MONTHLY
January, 1926, to Date

October, 1927	**204.40**
September, 1927	203.60
October, 1926	209.80
Peak, June, 1920	273.80
1913	100.00

1926

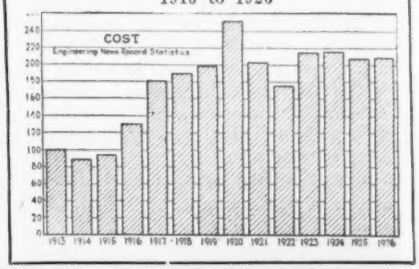
Jan.	207.15	May	207.30	Sept.	208.30
Feb.	206.55	June	204.80	Oct.	209.80
Mar.	207.65	July	207.80	Nov.	210.80
April	207.05	Aug.	208.30	Dec.	210.80

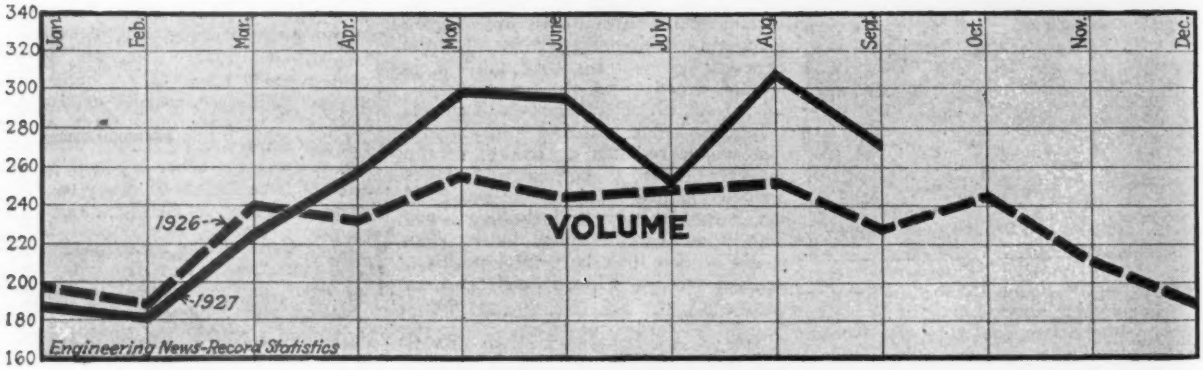
1927

Jan.	211.50	April	209.00	July	203.68
Feb.	210.15	May	206.80	Aug.	205.50
Mar.	208.80	June	205.55		

Engineering News-Record's Construction Cost Index Number is 0.3 per cent above September, 1927. The increase is due to slightly higher rates for 3-in. timbers. The average rate for common laborers is 54½c. per hour. Thus, general construction cost is 2¼ per cent below October, 1926, and 25 per cent under the peak. It is also 104 per cent above 1913.

YEARLY
1913 to 1926





Engineering News-Record CONSTRUCTION VOLUME Index Number (1913 = 100)

MONTHLY
January, 1926, to September, 1927

September, 1927	**273**
August, 1927 (record)	306
September, 1926	227
1913	100

1926

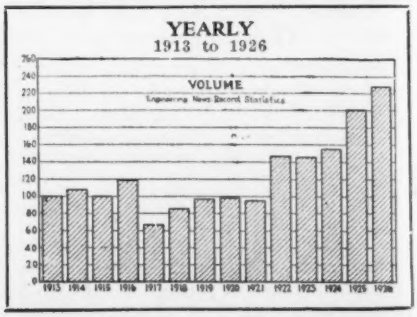
Jan.	198	May	254	Sept.	227
Feb.	187	June	246	Oct.	244
Mar.	240	July	248	Nov.	211
April	233	Aug.	252	Dec.	188

1927

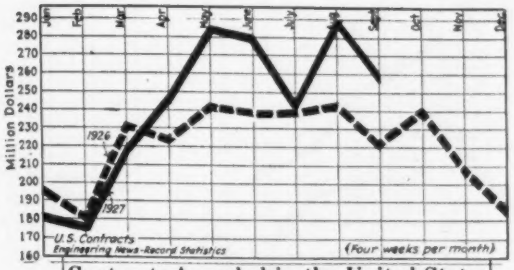
Jan.	187	April	257	July	252
Feb.	182	May	299	Aug.	306
Mar.	226	June	297		

Engineering News-Record's Construction Volume Index Number is 273 for the month of September and 228 for the whole of 1926, as against 100 for 1913. This means that the actual volume of contract letting in 1926 (not the mere money-value of the contracts let that year) is 128 per cent above the volume for 1913. The monthly volume number, 273 for September, 1927, indicates the rate at which contracts are being let as compared with 1913 awards.

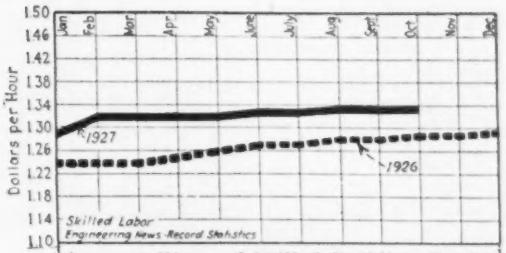
YEARLY
1913 to 1926



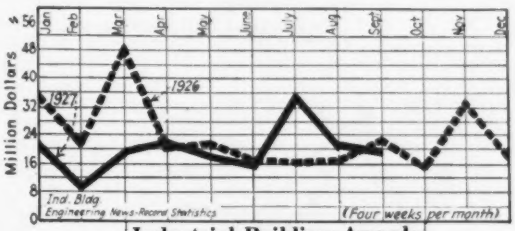
Monthly Statistics of the Construction Industry



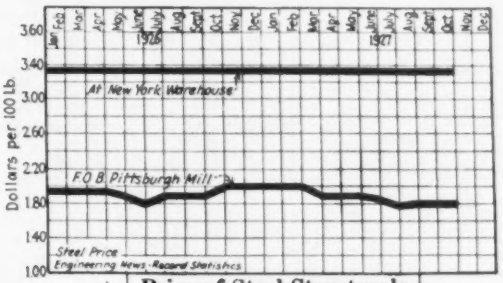
Contracts Awarded in the United States
Reported by E. N.-R.



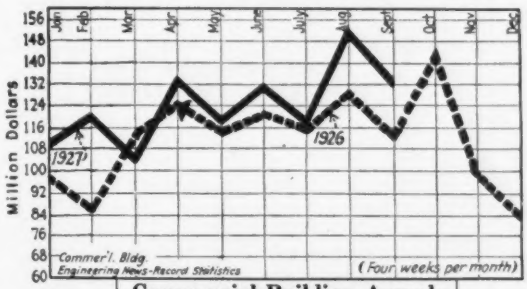
Average Wage of Skilled Building Trades
Bricklayers, Carpenters and Steel Erectors



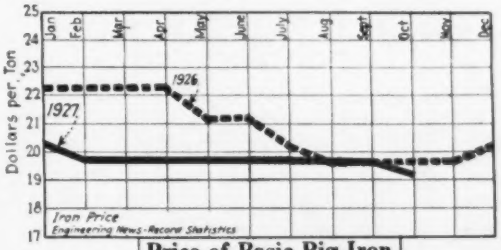
Industrial Building Awards
$40,000 and Over



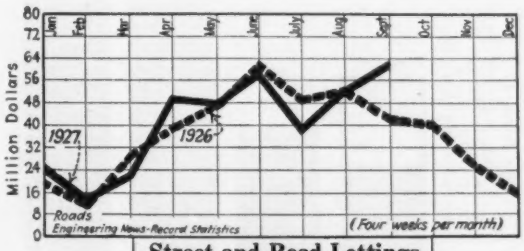
Price of Steel Structurals
Shapes 3-in; Plates ¼-in.



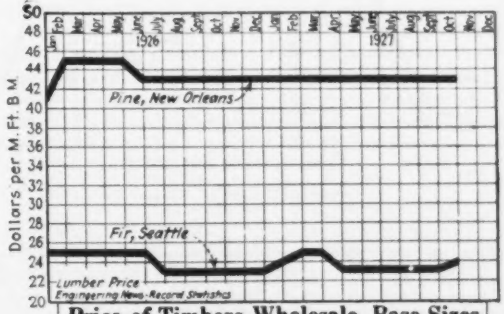
Commercial Building Awards
$150,000 and Over



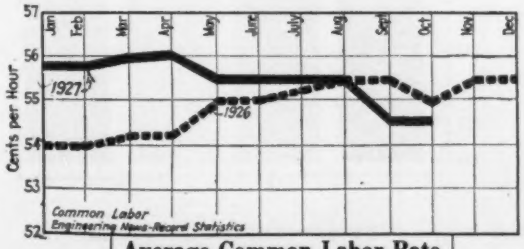
Price of Basic Pig Iron
F.o.b. Pittsburgh



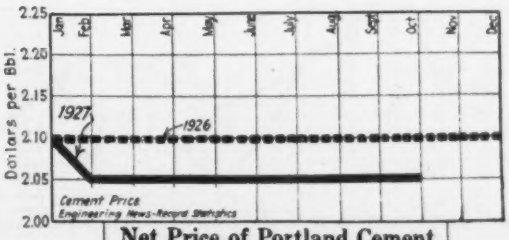
Street and Road Lettings
$25,000 and Over



Price of Timbers, Wholesale, Base Sizes
Car Lots to Contractors

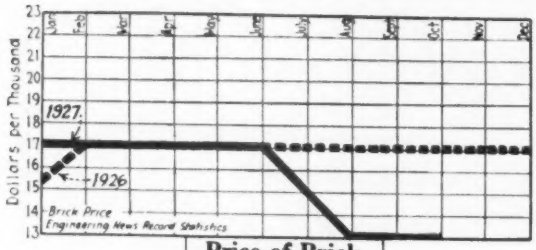


Average Common Labor Rate
Pick and Shovel Men

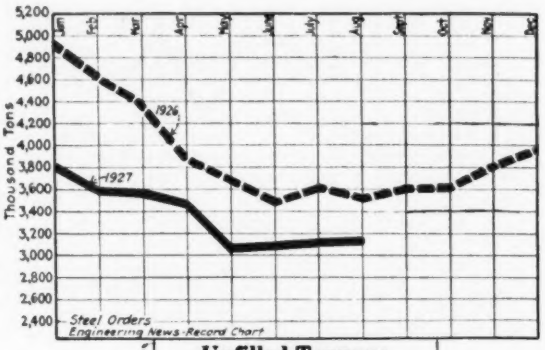


Net Price of Portland Cement
Car Lots F.o.b. Chicago

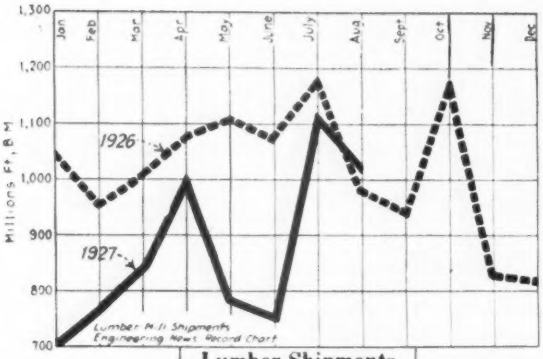
Monthly Statistics of the Construction Industry



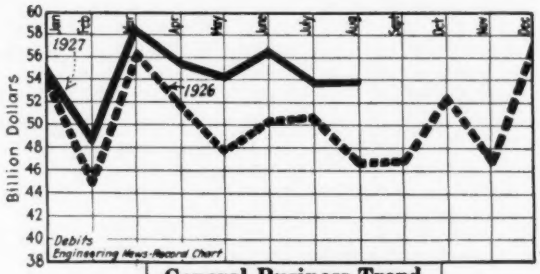
Price of Brick
At Dock, New York



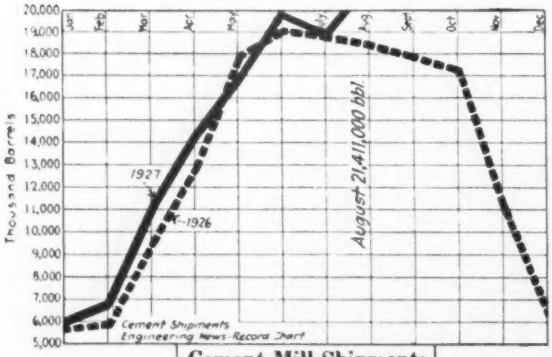
Unfilled Tonnage
On Books of U. S. Steel Corp.



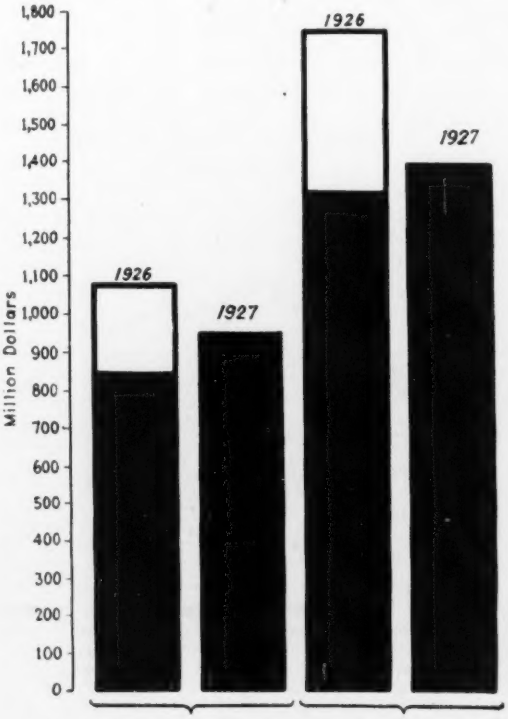
Lumber Shipments
Nat. Lumber Mfrs. Assn.



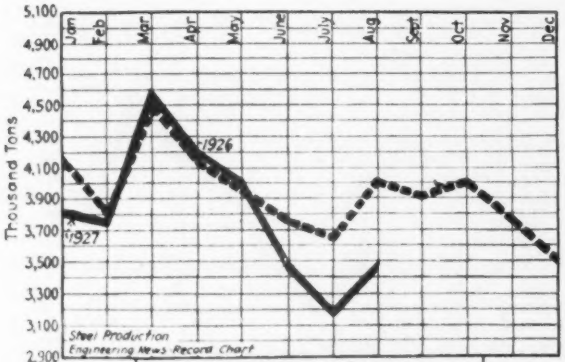
General Business Trend
Bank Debits—Federal Reserve



Cement Mill Shipments
Bureau of Mines



Public—Contracts—Private
Jan. 1 to date
Reported by E. N.-R.



Steel Ingot Ouput
Gross Tons; Am. Iron and Steel Inst.

Record Year Indicated By Contract Total For First Ten Months of 1927

September Gains, Compared With 1926, Largely In Public Work

THIS year, thus far, has provided ample grounds for belief that 1927 will hold the record for money spent in large engineering construction contracts.

A glance at the total in the accompanying table will show the lead gained this year over last.

Figures used here are for the nation as a whole, yet at the same time, only the contracts of major importance are included. These comprise all awards valued at $15,000 and over on waterworks and excavation, drainage, irrigation, levee, river and harbor projects; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial, educational, institutional, religious and other buildings.

The gain of 17 per cent in money value of September awards, compared with the same month last year, is accentuated by the fact that materials prices were substantially lower.

Every section of the country except New England, showed a gain last month, compared with September, 1926.

The normal seasonal variation in September contract letting (money value) over a period of fourteen years, 1913 to 1926, has been about 0.4 per cent gain over August. The normal condition of contract letting over a period of five years, 1922 to 1926, has been one where no marked change occurred between the September total and that of the month preceding.

While September shows substantial gains over the same month last year, average weekly lettings should have been at least 10 per cent heavier in order to bring the month up to its seasonal volume.

September gains compared with a year ago, were largely in public work. Commercial buildings, the only privately owned class of construction to show a gain, increased 20 per cent, compared with September, 1926.

Public buildings and Federal Government work were just about even with September of last year. Streets and roads gained 42 per cent. Bridges and excavation projects (publicly owned) more than doubled the September, 1926 volume. Three times more public work of unclassified nature was awarded in September, 1927, than during the corresponding period last year.

While all sections except New England gained, comparing September with the same month last year, the states responsible for the increases appear as follows: Middle Atlantic—New Jersey, Pennsylvania, Maryland and Delaware; South—Virginia, West Virginia, South Carolina, Georgia, Alabama, Mississippi, Kentucky and Tennessee; Middle West—Indiana, Illinois and Michigan; West of the Mississippi (between the river and the Rockies)—Iowa, Arkansas, North Dakota, South Dakota, Oklahoma, Texas, Wyoming and Colorado; Far West—Idaho, Arizona, Nevada and Washington. Vermont showed the only increase in New England.

VALUE OF CONTRACTS BY SECTIONS IN THE UNITED STATES AND TOTAL FOR CANADA

Thousands of dollars (-000 omitted)

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States	Jan. 1 to Date, U. S.	Canada
Water-works	$695	$701	$158	$584	$817	$169	$3,124	$44,337	$1,792
Sewers	199	1,225	880	4,576	1,452	1,812	10,144	87,325	187
Bridges	758	3,916	9,531	2,940	5,215	330	22,690	102,381	.....
Excavations, drainage, etc	53	99	1,380	820	102	69	2,523	36,843	1,428
Streets and roads	2,844	15,939	11,678	21,319	18,782	7,451	78,013	412,198	1,204
Industrial buildings	2,638	4,025	4,290	5,288	6,033	2,377	24,651	197,617	1,945
Commerical buildings	16,651	44,577	4,385	63,854	17,692	19,975	167,134	1,215,456	2,460
Federal government	68	371	1,794	454	934	1,568	5,189	37,317	.....
Unclassified	1,814	2,113	230	244	3,157	2,961	10,519	235,486	3,106
September, 1927	$25,720	$72,966	$34,326	$100,079	$54,184	$36,712	$323,987	$2,368,960	$12,122
August, 1927	20,430	183,025	25,843	73,773	51,095	35,178	289,344	.....	13,227
September, 1926	33,620	70,027	24,354	63,210	52,341	32,905	276,457	.....	8,254
January 1 to date, 1927	188,229	697,201	185,630	596,687	416,063	285,150	2,368,960	.....	88,537
January 1 to date, 1926	189,290	662,994	226,625	533,042	338,882	225,685	2,176,518	.....	95,096

Monthly Prices of Construction Materials

Important Changes In Cement, Cast-Iron Pipe and Steel

DEMAND for the principal construction materials, in the first nine months of 1927, was 8 per cent greater than that for the corresponding period last year, as shown by contract totals given in the table.

Cost of these materials together with that of labor, taking an average for the period Jan. 1 to Oct. 1, 1927, is 0.2 per cent under the average for the same months in 1926.

The present direction of the market for basic materials is downward. This movement is largely seasonal, and applies to the country as a whole, since several price advances of a local nature have developed during the last thirty days. Materials in which definite price fluctuations have occurred during the last month, are treated, in the order of importance, as follows:

Pig Iron—Prices lowest since 1916. Buying is confined to small lots with little indication of immediate improvement in volume of demand. No great increase can be expected in steel with pig iron in its present condition.

Cement—Prices changed in only five out of forty-five mill and f.o.b. points, from which reports are regularly received by *E. N.-R.* Effective Sept. 23, the price at Detroit dropped to $2 per bbl., from $2.15, f.o.b., in carload lots, exclusive of the cost of package. The decline at Montreal was rather steep; quotations in that city are now $1.41 per bbl., against $2.22, a month ago. The current level at Montreal, however, is still 26c. per bbl. above that of a year ago. Substantial declines at two Michigan mills went into effect during the month. The price at Wyandotte dropped from $1.90 to $1.75 per bbl., net, and that at Alpena, from $1.75 to $1.60. Two reasons are given by the manufacturers for the declines in the Michigan district: "First, to provide a wider margin on all dealers' cement sales, requiring truck or team delivery on the job, without the necessity of dealers raising present resale price levels; second, to further stimulate and promote increased fall and winter building." The price at New Orleans, however, rose 10c. per bbl. during the month. This increase was based on the smaller volume of foreign cement received at New Orleans during September. The foregoing cement price changes are evidently local in effect and not seasonal in nature, since at this time last year no changes were recorded in forty-six localities reporting to *E. N.-R.*

Cast-Iron Pipe—Prices have sagged $2 per ton at all points during the last two weeks. The Birmingham base, 6-in. and over, Class B and heavier, is now $30 per net ton. In the opinion of one of the principal makers "quotations as low as $28, Birmingham, have been made by some companies but it is doubtful whether the whole market is as low as that."

Steel—Structural shapes, plates and bars are now $1.75 per 100 lb., base, Pittsburgh, for orders involving several carloads. A price of $1.85 applies on a single carlot or less. For the last several months, a minimum rate of $1.80 per 100 lb., base, has been observed.

Building Trades Wage Rates Per Hour

Compiled By E. N-R.

	Bricklayers	Carpenters	Hoisting Engineers	Hod Carriers	Pile Drivers	Structural Iron Workers	Common Laborers
Akron, O.	$1.55	$0.80@$1.25	$1.00	$0.75	$0.50@$0.60	$1.00@$1.10	$0.45
Albany, N. Y.	1.50	1.25	1.43¾	.75	1.25	1.37½	.75
Altoona, Pa.	1.35	.85	1.25	.75	.....	.80@1.00	.45
Amarillo, Tex.	1.62½	1.12½	1.25	1.00	.....	1.25@1.37½	.50
Atlanta, Ga.	1.40	.70	.70	.50	.....	.75	.25@ .30
Baltimore, Md	1.62½@1.75	1.00@1.10	1.00@1.37½	1.00	.65	1.00@1.25	.40
Birmingham, Ala	1.00@1.50	1.05	1.00	.50@ .75	.....	1.75	.25@ .40
Boston, Mass	1.40	1.25	1.25	.79	1.15	1.25	.45@ .74
Bridgeport, Conn.	1.37½	1.25	1.00	.85	1.00	1.00@1.25	.75
Calgary, Alta	1.35	1.00	.60@ .65	.40@ .55	.60@ .65	.70@ .77	.40@ .55
Charleston, W. Va.	1.50	1.12½	1.00@1.12½	.75	.....	1.12½	.40@ .50
Chicago, Ill.	1.62½	1.10@1.50	1.00@1.50	.90@ .96¼	1.50	1.50	.82½@ .90
Cincinnati, O.	1.68¾	1.25	1.25	.75	.....	1.25	.45
Cleveland, O.	1.62½	1.37½	1.37½	.87½	1.10	1.50	.87½
Columbus, O.	1.56¼	1.25	1.15@1.20	.90	.....	1.25	.50
Dallas, Tex.	1.67½	1.12½	1.25	.75	1.25	1.25	.35@ .50
Denver, Colo.	1.50@1.62½	1.25	1.25@1.37½	.87½@1.00	.....	1.25	.31¼@ .50
Des Moines, Ia.	1.50	1.12½	1.07½	.90	1.25	1.25	.67½
Detroit, Mich.	1.56¼	1.00 @ 1.25	1.00@1.10	.90	1.00@1.10	1.00@1.25	.50@ .60
Duluth, Minn.	1.25	.90	.87½	.55	.87½	.90	.45@ .50
Fort Wayne, Ind	1.45	.90@1.00	.75@1.00	.50@ .90	.....	.75@1.00	.45@ .60
Ft. Worth, Tex.	1.67½	1.12½	1.25	.75	1.25	1.25	.35@ .50
Galesburg, Ill	1.25	1.12½	1.00	.60	95	.....	.35@ .50
Great Falls, Mont	1.50	1.12½	.75	1.00	.62½@ .87½	.87½	.62½
Indianapolis, Ind	1.62½	1.20	.85	.92½	1.05	1.40	.45
Jacksonville, Fla.	1.50	1.00	1.00@1.12½	.30@ .50	.80@1.00	1.00	.30@ .50
Kansas City, Mo	1.50	1.25	1.25	.90	1.25	1.25	.35@ .75
Knoxville, Tenn.	1.25	.80	.85	.35	.85	.75	.30
Los Angeles, Calif.	1.37½	1.00	1.00	.86½	.87½	1.00	.50
Louisville, Ky.	1.00@1.10	1.00	1.00	.75	.75@1.00	.95	.40
Madison, Wis	1.25	1.00	1.00	.90	.....	1.00	.60
Memphis, Tenn	1.62½	1.00	1.00	.62½	1.00	1.00	.30
Milwaukee, Wis	1.50	.80@1.00	.90@1.00	.80	1.10	1.00	.60
Minneapolis, Minn.	1.25	.87½@ .95	.87½	.75	.....	1.00	.45@ .60
Montreal, Que	1.25	.75	.75	.40	.50	.90@1.00	.30@ .35
Nashville, Tenn	1.50	1.00	.80	.50	.80	1.00	.30@ .50
New Orleans, La	1.50	.90	1.25	.75	.80@1.00	1.25	.30@ .40
New York, N. Y.	1.75	1.50	1.75	1.12½	1.00@1.12½	1.75	.90⅝
Norfolk, Va.	1.50	.80	.87½@1.00	.55@ .65	.....	.85	.40
Oklahoma City, Okla.	1.75	1.60	1.00	.....	.....	1.00	.50
Olympia, Wash.	1.37½	1.00	1.12½	.87½	.....	1.25	.68¾
Omaha, Neb.	1.37½	1.00	1.12½	.65@ .75	1.12½	1.12½	.40@ .50
Ottawa, Ont.	1.10	.75@1.10	.75	.45	.....	.72½@ .75	.45@ .50
Philadelphia, Pa.	1.62½	1.12½@1.25	1.02¼	.70@1.12½	1.00	1.37½@1.50	.45@ .50
Pittsburgh, Pa.	1.70	1.50	1.50	1.12½	.....	1.50	.40@ .80
Portland, Me.	1.30	.90	.90	.70	.....	1.25	.55@ .65
Pueblo, Colo.	1.50	1.12½	.....	.75	1.25	1.25	.50
Raleigh, N. C.	.90@1.25	.60@ .90	1.00	.30	.50@ .60	1.25	.30
Richmond, Va.	1.50	.80@1.00	.92½@1.00	.50@ .60	1.00	.87½@1.12½	.25@ .35
Saint John, N. B.	1.00	.50@ .60	.40	.30	.....	.....	.30
St. Louis, Mo.	1.75	1.50	1.50@1.65	1.15@1.25	1.25	1.50	.40@ .75
San Antonio, Tex.	1.50	1.00	.87½@1.00	.44	1.12½	1.00	.32½
San Diego, Cal.	1.75	1.12½	1.00	1.00	1.00	1.12½	.62½
San Francisco, Calif.	1.37½	1.12½	1.06¼	.87½	1.12½	1.37½	.62½
Seattle, Wash.	1.37½	1.12½	1.00@1.12½	1.00	1.00@1.12½	1.12½@1.25	.62½@ .70
Syracuse, N. Y.	1.50	1.15	1.50	.75	.....	1.50	.75
Tallahassee, Fla.	1.50	.75	.50	.30	.60	.75	.25
Topeka, Kans.	1.50	1.00	1.25	1.00@1.25	1.00	1.00@1.25	.35@ .50
Toronto, Ont.	1.25	.90	.75@ .85	.55@ .75	.55@ .75	.75	.40@ .60
Trenton, N. J.	1.50	1.40	1.75	.80@1.00	.....	1.75	.45
Vancouver, B. C.	1.25	.89¾	.87½@1.06	.....	.89¾	1.12½	.50@ .60
West Palm Beach, Fla.	1.75	1.25	1.50	.75	1.50	1.50	.50
Wheeling, W. Va.	1.50	1.25	1.37½	.50	1.37½	1.37½	.45@ .50
Wilmington, Del.	1.62½	1.00	1.25@1.35	1.00	1.00	1.25	.45

UNION wage scales obtain in the following; those in parentheses are union trades in an otherwise non-union city:

Akron, O. (bricklayers and hod carriers)
Albany, N. Y.
Altoona, Pa. (bricklayers)
Amarillo, Tex.
Bridgeport, Conn.
Calgary, Alta. (bricklayers and carpenters)
Charleston, W. Va. (bricklayers, carpenters, hoisting engineers and structural ironworkers)
Columbus, O.
Dallas, Tex. (all except pile drivers and common laborers)
Des Moines, Ia.
Ft. Wayne, Ind.
Ft. Worth, Tex. (same as Dallas)
Galesburg, Ill. (bricklayers, carpenters, hod carriers)
Great Falls, Mont. (town union)
Jacksonville, Fla. (carpenters, bricklayers, structural ironworkers)
Knoxville, Tenn.
Louisville, Ky.
Madison, Wis.
Memphis, Tenn.
Milwaukee, Wis.
Nashville, Tenn. (bricklayers, carpenters, ironworkers)
Norfolk, Va.
Oklahoma City, Okla. (bricklayers, carpenters, hoisting engineers)
Olympia, Wash.
Omaha, Neb.
Portland, Me.
Pueblo, Colo.
Richmond, Va. (all except hod carriers and common laborers)
San Antonio, Tex. (all union except hoisting engineers)
San Diego, Calif.
Syracuse, N. Y.
Tallahassee, Fla. (bricklayers, carpenters)
Topeka, Kans.
Toronto, Ont. (bricklayers, carpenters, hoisting engineers, ironworkers)
Trenton, N. J.
Vancouver, B. C. (all union rates except common laborers)
West Palm Beach, Fla. (all union except common laborers)
Wheeling, W. Va. (all except hod carriers and common laborers)
Wilmington, Del. (all union except common laborers)

E. N.-R. Prices of Construction Materials

Price advances since last month are indicated by **heavy type**; declines by *italics*

PIG IRON—Per Gross Ton f.o.b.:

	Oct. 6	One Year Ago
CINCINNATI		
No. 2 Southern (silicon 2.25@2.75)	$21.44	$24.19
Northern Basic	20.89	20.39
No. 2 Southern Ohio (silicon 1.75@2.25)	21.19	21.39
NEW YORK, tidewater delivery		
Southern No. 2 (silicon 2.25@2.75)	25.62	27.37
BIRMINGHAM		
No. 2 Foundry (silicon 2.25@2.75)	17.75	20.00
PHILADELPHIA		
Eastern Pa., No. 2X (2.25@2.75 sil.)	21.76	22.76
Virginia No. 2 (silicon 2.25@2.75)	27.17	28.67
Basic	21.26	21.26
CHICAGO		
No. 2 Foundry Local (silicon 1.75@2.25)	21.00	21.75
No. 2 Foundry Southern (silicon 2.25@2.75)	22.80	25.05
PITTSBURGH, including freight charge ($1.76) from the Valley		
No. 2 Foundry Valley (silicon 1.75@2.25)	20.26	19.76
Basic	*19.26*	19.76
Bessemer	21.26	19.76

SCRAP—The prices following are f.o.b. per ton paid by dealers:

	New York	Chicago	Birmingham
No. 1 railroad wrought	*$11.50*@*$12.00*	*$11.25*@*$11.75*	$11.00@$12.00
Stove plate	9.25@ 9.50	13.00@ 13.50	13.00@ 14.00
No. 1 machinery cast	*12.50*@ *14.00*	*14.25*@ *14.75*	15.00@ 16.00
Machine shop turnings	**7.00@ 7.50**	7.00@ 7.50	8.00@ 8.50
Cast borings	7.25@ 7.75	9.50@ 10.00	8.00@ 8.50
Railroad malleable	**10.25@ 10.75**	*12.50*@ *12.75*	12.00@ 13.00
Re-rolling rails	**10.25@ 10.75**	*13.50*@ *14.00*	15.00@ 16.00
Re-laying rails	*23.00@ 24.00*	.....	22.00@ 23.00
Heavy melting steel	*7.00 @ 10.75*	*11.00@ 11.50*	12.00@ 12.25
Iron and steel pipe	7.75@8.25	.....	.....

Railway Supplies

STEEL RAILS—The following quotations are per gross ton f.o.b. for carload or larger lots. For less than carload lots 5c. per 100 lb. is charged extra:

	Pittsburgh				
	Oct. 6	One Year Ago	Birmingham	Chicago	St. Louis
Standard bessemer rails	$43.00	$43.00	$43.00	$43.00	.....
Standard openhearth rails	43.00	43.00	43.00	43.00	$49.50
Light rails, 8 to 10 lb.	.....	.....	34@36	1.80@1.90*	1.90*
Light rails, 12 to 14 lb.	.....	.....	34@36	1.80@1.90*	1.80*
Light rails, 25 to 45 lb.	36.00	34@36	34@36	1.80@1.90*	1.78*
Re-rolled rails	30@*32*	30@33	34@36	34@36	17@18

*Per 100 lb.

RAILWAY TIES—For fair-sized orders, the following prices per tie hold:

	6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
Chicago, white oak, plain	$1.45	$1.83
Chicago, empty cell creosoted	1.85	2.45
Chicago, zinc treated	1.65	2.15
San Francisco, green Douglas fir	.84	1.14
San Francisco, empty cell creosoted, Douglas fir	1.70	2.25
St. Louis, white oak, plain	1.25	1.50
St. Louis, zinc treated	1.65	1.90
St. Louis, red oak, plain	1.15	1.40
St. Louis, sap pine-cypress	1.00	1.25
Birmingham, white oak	1.25	1.45

TRACK SUPPLIES—The following prices are base per 100 lb. f.o.b. Pittsburgh mill for carload lots, together with the warehouse prices at the places named:

	Pittsburgh					
	Oct. 6	One Year Ago	Chicago	St. Louis	San Francisco	Birmingham
Standard spikes, ⅝-in. and larger	$2.80	$2.80@2.90	$3.55	$3.65	$3.85	$3.00
Track bolts	3.90@4.25	3.90@ 4.25	4.55	4.60	5.35	3.90
Standard section angle bars, splice bars or fish plates	*2.75*	2.75@2.95	3.40	3.75	4.25	2.95

Pipe

WROUGHT STEEL AND IRON PIPE—The following basing discounts from list are to jobbers for carload lots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62	50½	1 to 1½	30	13
LAP WELD					
2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1½	30	14
2 to 3	61	50½			
LAP WELD, EXTRA STRONG, PLAIN ENDS					
2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

WROUGHT-STEEL PIPE—From warehouses at the places named the following discounts from list, hold for welded steel pipe:

	Black		
	New York	Chicago	St. Louis
1 to 3 in. butt welded	53%	54%	49%
2½ to 6 in. lap welded	48%	51%	46%
	Galvanized		
	New York	Chicago	St. Louis
1 to 3 in. butt welded	39%	41%	36%
2½ to 6 in. lap welded	35%	38%	33%

Malleable fittings, Classes B and C, banded, from New York stock sell at list plus 4% less 5%. Cast iron, standard sizes, 36 – 5% off.

CAST-IRON PIPE—The following are prices per net ton for Class B and heavier, f. o. b., in carload lots:

	Birmingham	Burlington, N. J.	New York Oct. 6	New York One Year Ago
4 in.	*$34.00*	*$44.00*	*$46.60*	$54.60@55.60
6 in. and over	*30.00*	*40.00*	*42.00*	50.60@51.60
	Pittsburgh	Chicago	St. Louis	San Francisco
4 in.	*$42.50*	*$42.20*	*$39.60*	*$45.00*
6 in. and over	*38.50*	*38.20*	*35.60*	*41.00*

Gas pipe and Class "A," $4.00 per ton extra.

CLAY DRAIN TILE—The following prices are per 1,000 lin.ft.:

	New York					
Size, In.	Oct. 6	One Year Ago	St. Louis	Birmingham	San Francisco	Dallas
3	$45.00	$45.00	.....	$45.00	.....	$73.00
4	56.00	55.00	$35.00	56.00	$76.50	90.00
5	.....	.....	.....	80.00	97.75	118.00
6	80.00	90.00	65.00	100.00	127.50	150.00
8	150.00	160.00	150.00	165.00	212.50	210.00

SEWER PIPE—The following prices are in cents per foot for standard pipe in car load lots, f.o.b., except as otherwise stated:

Size, In.	New York Delivered	Pittsburgh	Birmingham	St. Louis	Chicago	San Francisco	Dallas
3	....	$0.072	$0.10	.....	$0.088	$0.12	.....
4	....	.072	.10	$0.0875	.088	.15	$0.15
5	....	.099	.135	....	.11	.18	.18
6	$0.22	.099	.21	.1225	.11	.21	.21
8	.36	.162	.315	.20	.18	.30	.38
10	.52	.2415	.45	.28	.2625	.42	.53
12	.66	.3105	.54	.36†	.3375	.56	.70
15	1.12†	.414	.75	.60†	.45	.92	*1.01*
18	1.62†	.575	.90	.84†	.675†	1.32	*1.32*
20	1.95†	.69	1.20	.....	1.05†	.....	.....
21	.....	.805	.....	1.12†	1.225†	.....	.....
22	2.60†	.92	1.35	.....	1.40†	.....	1.83
24	2.92†	1.035	2.665	1.44†	1.575†	2.16	2.27
27	4.62†	2.08	2.952	2.45†	2.75†	3.00	3.34
30	5.12†	2.304	3.96	3.00†	3.75†	3.60	4.06
33	6.93†	4.05	4.51	3.55†	4.50†	.....	4.99
36	7.91†	4.6125	5.06	3.95†	5.00†	.....	5.42

	3	5	8	12	24	36
Boston	**$0.125**	$0.175	$0.25	$0.47	$1.80†	$5.10†
Minneapolis	....	....	.25	.45	1.50	4.56
Denver	.135*	.18*	.27	.47	1.70	.....
Seattle	.14	.....	.35	.63	2.52	.....
Los Angeles	.1675	.186	.2825	.5085†	2.034†	.....
New Orleans	*.10**	.....	*.26*	*.425*	*1.625*	3.50
Cincinnati	.105	.1575	.245	.4725	1.575	4.715
Atlanta	.10*	.15*	.25	.425	1.625	.....
Montreal	....	.25	.45	.675	2.25	.....
Detroit	.081	.122	.189	.405	2.07†	4.715†
Baltimore	.111	.166	.259	.499	1.665	4.92
Kansas City, Mo.	.15*	.21*	.29	.52	1.90†	3.80†
Philadelphia	.105	.15	.245	.40	1.40	3.50

*4-in., 6-in., 9-in., respectively. †Double Strength.

Road and Paving Materials

ROAD OILS—Following are prices per gallon in tank cars, 8,000 gal. minimum f.o.b. place named:

		Oct. 6	One Year Ago
New York, 45% asphalt	(at terminal)	$0.0725@$0.075	$0.065 @$0.07
New York, 65% asphalt	(at terminal)	.0675@ .0725	.0625@.0725
New York, binder	(at terminal)	.07 @ .075	.07 @.075
New York, flux	(at terminal)	.07 @ .075	.07 @.075
New York, liquid asphalt	(at terminal)	.07 @ .075	.07 @.075
St. Louis, 40@50% asphalt		.052	.055
St. Louis, 50@60% asphalt		.0554	.0565
Birmingham, 55% asphalt		.0475	.0475
Dallas, 45% asphalt		.0495	.0495
Dallas, 50% asphalt		.0455	.0455
Dallas, binder		.061	.061
San Francisco, binder, per ton		12.00*	12.00*

* F.o.b. Oleum, Cal. Freight to San Francisco, 80c. per ton.

E. N.-R. Prices of Construction Materials

ASPHALT—Price per ton in packages (350-lb. bbls. or 425-lb. drums) and in bulk in carload lots, f.o.b. points listed:

	Package	Bulk
New York (*Texas*)	$24.50	.....
Boston (*Mexican*)	23.50	$19.00
Chicago (*Texas*)	**24.00**	18.50
San Francisco, *f.o.b. refinery*, Oleum, Cal.	18.00	12.00
Dallas (*Texas*)	27.10	21.10
Seattle, *"D" grade, California, f.o.b. Richmond*	19.50	13.50
Denver (*California*)	24.00	.....
Minneapolis, *f.o.b. Twin Cities* (*Stanolind*)	28.10	22.10
St. Louis (*Mexican*)	26.00	23.00
Baltimore (*Standard Oil*) (*f.o.b. refinery*)	22.50	18.50
Montreal (*Imperial*)	27.00	22.50
Atlanta (*Mexican*)	24.40	19.40
Detroit (*Mexican*)	24.00	19.00
Cincinnati (*Kentucky Rock*)	.....	11.65
Maurer, N. J. (*Bermudez*)	30.00	.....
Maurer, N. J. (*Trinidad*)	23.00	.....
Philadelphia (*Mexican*)	20.00	18.00
Kansas City, Mo. (*Texas*)	**28.30**	**23.30**
Los Angeles (*"D" grade, California*)	*18.00	*12.00
Birmingham (*Mexican*)	27.00	21.00
New Orleans (*Mexican*)	20.00	17.00

*F.o.b. El Segundo Refinery. Drums used in New York.

NOTE—Barrels or drums are optional in most cities. About 6 bbls. to the ton, and from 4 to 5 drums; 200 to 300 gal. to the ton.

PAVING STONE—

New York (grade 1). 5-in. granite, 30 blocks per sq.yd		$150.00 per M.
San Francisco	Basalt block 4x7x8	70.00 per M.
Chicago	about 5x8x5 dressed	3.60 per sq.yd.
	about 5x8x5 common	3.25 per sq.yd.
Boston	5-in. Granite	135.00 per M.
Atlanta	Granite	2.50 per sq.yd.
Detroit	5-in. Granite	3.00 per sq.yd.
Baltimore	Granite	2.85 per sq.yd.
Montreal	Granite	104.75 per M.
New Orleans	Granite, 4x8x4	2.75 per sq.yd.
Cincinnati	Granite	135.00 per M.
St. Louis	Granite, 4x8x4	1.65 per sq.yd.
Kansas City	Granite	3.85 per sq.yd.
Philadelphia	Granite	3.90@4.25 per sq.yd.
Minneapolis	Sandstone	2.74 per sq.yd.

FLAGGING—

New York	Bronx, 4 ft. wide	$0.24 per sq.ft.
	Manhattan, 4 ft. wide	.24 per sq.ft.
	Queens, 5 ft. wide	.26 per sq.ft.
	6x24-in. cross-walk	1.30 per lin.ft.

CURBING—*New York*: Bluestone per lin.ft., f.o.b. barge New York, 5x16 in., 90c.; *St. Louis*: Class "A" straight, delivered, 5x18 in., 90c. per lin.ft., roundings, $1.55. *Birmingham*: Limestone, 5x18-in., $1.05 per lin.ft.

WOOD BLOCK PAVING—

	Size of Block	Treatment	Per Sq. Yd.
New York	3	16	$2.40
New York	3½	16	2.70
Boston	3½	18	2.40
Chicago	4	16	2.25
Chicago	3½	16	2.10
St. Louis	3½	16	2.25
St. Louis	4	16	2.50
Seattle	4	16	Off market
Minneapolis	3½	16	2.50
Atlanta	3½	16	2.00
New Orleans	3	16	2.20
New Orleans	3½	16	2.30
New Orleans	4	16	2.40
Dallas	4	18	3.90
Baltimore	3½	16	None used
Montreal	4	16	4.50
Detroit	3	16	1.94
Cincinnati	3½	16	2.35
Kansas City	4	16	2.50
Philadelphia	4	16	None used

Construction Materials

SAND AND GRAVEL—Price for cargo or carload lots to contractors, f.o.b., per cu.yd. Weight of sand, 1½ tons per cu.yd.; gravel, 1½ tons per cu.yd. unless otherwise specified in pounds.

	Gravel 1½ In.		Gravel ¾ In.		Sand	
	Oct. 6	One Year Ago	Oct. 6	One Year Ago	Oct. 6	One Year Ago
New York (*alongside dock*)	$1.75	$1.75	$1.75	$1.75	$1.00	$1.00
Denver (*2,700*)	1.90	1.90	1.90	1.90	1.00	1.00
Chicago (*3,000*)	2.00*	1.60	2.00*	1.60	2.00*	1.40
St. Louis	1.45†	1.45†	1.45†	1.45†	1.20†	.93‡
Seattle	1.25	1.50	1.25	1.50	1.25	1.50
Dallas	2.38*	2.38*	2.38*	2.38*	2.00*	2.00*
Minneapolis (*2,800*)	1.25†	1.65	1.25†	1.65	1.25	1.25
Cincinnati	1.30†	1.30†	1.30†	1.30†	1.05†	1.05†
San Francisco	1.80	1.80	1.80	1.80	1.40	1.40
Boston (*on trucks at dock*)	1.75†	1.50†	1.75†	1.50†	1.25†	1.00†
New Orleans	1.95†	.....	1.95†	.....	1.40†	1.80†
Los Angeles	2.00†*	1.15†	2.00†*	1.15†	1.40†	1.10†
Atlanta	2.20†*	1.90†	2.20†*	1.90†	1.75†	1.60†
Detroit (*2,600*)	1.70	1.45†	1.60	1.35†	1.35	1.10†
Baltimore	1.40	1.40	1.60	1.60	.70‡‡	.70‡‡
Montreal	1.90†	1.25†	1.50†	1.50†	1.35†	1.25†
Birmingham (*2,700*)	1.54	2.00*	*1.54*	2.00*	*1.19*	1.50
Philadelphia (*2,950*)	2.25*	2.10*	2.25*	2.10*	1.65	1.50
Kansas City, Mo.	.....	.....	.....	.....	.66‡†	.66‡†
Pittsburgh	.85‡	.....	.85‡	.....	1.25	.....

*Delivered †Per ton. ‡At pit Note: New York in truckload lots. Gravel weighs 2,800@3,000 lb.; sand, 2,700 lb.

CRUSHED STONE—Prices are for cargo or carload lots, per cu.yd. f.o.b. city. Weight 1½ tons per cu.yd., unless otherwise specified in pounds:

	1½ In. Oct. 6	1½ In. One Year Ago	¾ In. Oct. 6	¾ In. One Year Ago
New York (*L*)	$1.75	$1.84	$1.85	$1.94
Chicago (*L*)	2.00†	1.70	2.00†	1.87½
St. Louis	1.83*	1.83*	1.83*	1.83*
Dallas	2.40†	2.40†	2.83†	2.83†
San Francisco	1.70	1.70	1.70	1.70
Boston (*on trucks at dock*)	2.00*	1.60*	2.00*	1.65*
Minneapolis (*L*) (*2,600*)	1.25*	1.75	1.25*	1.75
Kansas City (*L*) (*2,450*)	1.35	2.00†	1.35	2.00†
Denver (*G*) (*2,700*)	2.50†	2.50†	2.50†	2.50†
Seattle	3.00†	3.00†	3.00†	3.00†
Atlanta	2.50*†	2.50*†	2.50*†	2.50*†
Cincinnati	1.65*	1.65*	1.65*	1.65*
Los Angeles	2.00*†	1.40*	2.00*†	1.40*
Detroit (*L*) (*2,600*)	2.60*†	1.85*†	2.60*†	1.85*†
Baltimore	2.50†	2.50†	2.55†	2.55†
Montreal	1.80*	1.80*	2.00*†	2.00*†
Philadelphia (*L*) (*2,590*)	2.25†	2.10†	2.25†	2.10†
Pittsburgh	2.75†	2.85†	2.75†	2.85†
Cleveland	2.70*†	2.70*†	2.70*†	2.70*†
Birmingham (*L*)	.85‡	2.00†	1.00‡	2.00†

* Per ton. † Delivered. ‡ At Crusher. *L*-Limestone. *G*-Granite. *T*-Trap rock. Note: New York in truck-load lots.

CRUSHED SLAG—Price of crushed slag in carload lots, per net ton, at plant:

	1½-In.	¾-In.	Roofing	Sand
Youngstown District	$1.30	$1.40	$2.00	$1.30
Buffalo District	1.25	1.35	2.25	1.25
Birmingham, Ala.	.90	1.25	2.05	.80
Cleveland, Ohio	1.20	1.20	.....	1.30*
Eastern Pa. and Northern N. J.	1.25	1.25	2.00	1.25
Western Pennsylvania	1.25	1.25	2.00	1.25
Toledo, Ohio	1.25	1.25	1.50	1.25

*Includes freight charge.

LIME—Warehouse prices:

	Hydrated, per Ton Finishing	Hydrated, per Ton Common	Lump, per Barrel Finishing	Lump, per Barrel Common
New York	**$19.45**	**$12.10**	$3.50*	$2.35@**2.50***
Chicago	20.00	18.00	.....	1.50†
St. Louis	23.50	17.50	.....	2.03*
Boston	18.20	*10.50*	3.50*	2.10@2.75*
Dallas	19.00	.....	.....	1.82†
Cincinnati	16.80	11.90	.....	11.40‡
San Francisco	27.50	24.00	.....	1.70†
Minneapolis	25.50	21.00	.....	1.70†
Denver	24.00	.....	.....	2.70*
Detroit	15.50	11.50	.....	12.00‡
Seattle, *paper sacks*	24.00	.....	.....	2.80*
Los Angeles	26.00	18.00	2.40†	14.00‡
Baltimore	24.25	17.85	2.55	.....
Montreal	.....	21.00	.....	10.00‡
Atlanta	24.50	13.50	.....	1.50†
New Orleans	24.00	17.00	.....	2.00*
Philadelphia	23.00	15.00	.....	.....
Kansas City	19.00	17.50	.....	2.50*
Birmingham	22.50	16.00	2.40†	1.85†

*Per 280-lb. bbl. (net). †Per 180-lb. (net). ‡ Per ton.

NATURAL CEMENT—Price to dealers per bbl. for 500 bbl. or over, exclusive of bags:

	Oct. 6	One Year Ago
Minneapolis (Rosendale)	$2.80	$2.80
Kansas City (Ft. Scott)	1.35	1.45
Cincinnati (Utica)	1.72	1.72
Boston (Rosendale)	**2.25**	2.65
St. Louis (Carney)	2.85	2.25
Birmingham (Magnolia) pozzolan cement	2.40	2.40

PORTLAND CEMENT—Prices to contractors, per bbl. in carload lots, f.o.b. points listed, *without charge for bags*. Cash discount not deducted.

	Oct. 6	One Month Ago	One Year Ago
New York, del. by truck	$2.35	$2.35	$2.50@$2.60
New York, alongside dock to dealers	2.03	2.03	2.15
Jersey City	2.13	2.13	2.33
Boston	2.05	2.05	2.30
Chicago	2.05	2.05	2.10
Pittsburgh	2.04	2.04	2.09
Cleveland	2.24	2.24	2.29
Detroit	*2.00*	2.20	2.15
Indianapolis	2.19	2.19	2.29
Milwaukee	2.20	2.20	2.25
Duluth	2.04	2.04	2.09
Peoria	2.22	2.22	2.27
Cedar Rapids	2.24	2.24	2.34
Davenport	2.24	2.24	2.29
St. Louis	2.05	2.05	2.20
San Francisco	2.51	2.51	2.31
New Orleans	**2.07**	2.50	2.30
Minneapolis	2.22	2.22	2.32
Denver	2.85	2.85	2.85
Seattle	2.65	2.65	2.65
Dallas	2.05	2.05	2.05
Atlanta	2.40	2.40	2.35
Cincinnati	2.32	2.32	2.37
Los Angeles	2.56	2.56	2.36
Baltimore	2.50	2.50	2.50
Birmingham	2.40	2.40	2.40
Kansas City, Mo.	2.07	2.07	2.35
Montreal	*1.41*	2.22	1.15
Philadelphia	2.40	2.40	2.41
St. Paul	2.22	2.22	2.32
Toledo	2.20	2.20	2.20

NOTE—Bags 10c. each, 40c. per bbl.; 20c. each in Canada, 80c. per bbl.

Current mill-prices per barrel in carload lots, without bags, to contractors:

Buffington, Ind.	$1.80	Hudson, N. Y.	$1.75
Universal, Pa.	1.80	Leeds, Ala.	1.65
Steelton, Minn.	1.85	Hannibal, Mo.	1.90
Fordwick, Va.	2.05	Lehigh Valley District	1.75
Mitchell, Ind.	1.90	Wyandotte, Mich.	*1.75*
Iola, Kan.	1.85	Alpena, Mich.	*1.60*
Mason City, Ia.	1.80	Kingsport, Tenn.	2.05
La Salle, Ill.	1.90		

E. N.-R. Prices of Construction Materials

TRIANGLE MESH—Price per 100 sq.ft. in carload lots at mills; from warehouse in less-than-carload lots:

PLAIN 4-INCH BY 4-INCH MESH

Style Number	Weight in Pounds per 100 sq.ft.	Pittsburgh Mill	Chicago District Mill	Warehouse: New York	St. Louis	Dallas	San Francisco
052	22	$0.99	$1.01	$1.39	$1.06	$1.13	$1.22
049	28	1.26	1.29	1.76	1.35	1.38	1.55
058	35	1.54	1.58	2.16	1.66	1.67	1.91
093	45	1.98	2.03	2.77	2.13	2.00	2.46
126	57	2.45	2.51	3.45	2.63	2.55	3.03
153	68	2.92	2.99	4.11	3.14	3.15	.....
130	78	3.35	3.43	5.70	3.60	3.47	.....
245	103	4.43	4.53	6.21	4.75	4.58	.....
287	119	5.12	5.24	7.19	5.50	5.26	6.35
336	138	5.93	6.07	8.35	6.37	6.11	.....
395	160	6.88	7.04	9.65	7.38	7.12	.....
PAVING							
036P	17	$0.76	$0.77	$1.06	$0.81	$0.76	.....
053P	24	1.07	1.09	1.50	1.14	1.07	.....
072P	31	1.35	1.38	1.90	1.45	1.39	.....
097P	40	1.74	1.78	2.45	1.87	1.90	.....
049R	24	1.07	1.09	.....	1.14	1.02	.....
067R	31	1.35	1.38	.....	1.45	1.39	.....
089R	40	1.74	1.78	.....	1.87	1.90	.....

In rolls, 48-, 52-, and 56-in. wide and in 150-, 200- and 300-ft. lengths. Galvanized is about 15% higher. Size of roll carried in New York warehouses, 48 in. wide x 150 ft. long, or 600 sq.ft.

EXPANDED METAL LATH—Prices in less-than-carload lots per 100 yd. for painted:

Weight in pounds	New York	Birmingham	Chicago	St. Louis	San Francisco	Dallas
2.2	$17.50	$19 50	$17.50	$16.50	$17.00	$24.00
2.5	18.50	21.50	18.50	17.50	19.00	26.00
3.0	21.00	24.50	21.00	20.00	22.00	29.00
3.4	22.50	27.50	22.50	21.50	24.00	31.00

BARS, CONCRETE REINFORCING—Price per 100 lb., in carload lots, f.o.b. mill, Pittsburgh and Birmingham. In other cities listed, prices are for bars out of stock at warehouse.

ROLLED FROM BILLETS

Inches	Pittsburgh	Birmingham	Warehouse: New York	Chicago	St. Louis	Dallas	San Francisco
½ and larger	$1.75@1.85	$2.00	$3.24	$2.50	$3.15	$2.75	$2.95
⅝	1.85@ 1.95	2.10	3.34	2.60	3.25	2.85	3.05
¾	1.95@ 2.05	2.20	3.44	2.70	3.35	2.95	3.15
⅞	2.15@ 2.25	2.40	3.64	2.90	3.55	3.10	3.35
1	2.75@ 2.85	3.00	4.24	3.50	4.15	3.75	3.95

For standard classification of extras for size and cutting of steel bars, see bar card of July 15, 1923.

ROLLED FROM RAILS

	Warehouse: St. Louis	Dallas		St. Louis	Dallas
½ in and larger	$2.25	$2.48	⅝	$2 65	$2.88
¾	2 35	2.58	⅞	3.25	3.48
1	2 45	2.68	.....	.....	.....

BRICK—Contractors price, f.o.b., per M in cargo or carload lots is as follows:

	Common: Oct 6	One Month Ago	One Year Ago	Paving: 3x8½x4-in.	3½x8½x4-in
New York (del.)	$16@ 18	$17.00	$20.40@ 22.40	$45.00†	$51.00†
New York (at dock)	13 00	13.00	17.00	.....	.....
Chicago	12.00	12.00	12.00	42.00	45.00
St. Louis, salmon (del.)	15.00	15.00	15.00	40.00	42.50
Denver, salmon	8@12	8@12	9@10	.....	.....
Dallas	13 60	13 60	14.10	35.00	.....
San Francisco	14 00	14.00	15.00	.....	.....
Los Angeles	10.00	10.00	10.00	(not used)	
Boston (del.)	*18.00*	18.50	19 00	45.00	50.00
Minneapolis (del.)	13 75	13.75	13 75	.....	.....
Kansas City	**14 00**	12.50	14.50	(no market)	
Seattle	14.00	14.00	15.00	.....	55.00
Cincinnati	15.50	15.50	15.50	40.00	45.00
Montreal	20.25	20.25	20.25	100.00‡	.....
Detroit (del.)	*15.50*	16.00	14.00	35.25	38.50
Baltimore	18.00	18.00	18.00	40.00	45.00
Atlanta	12 50	12.50	10.50	40.00	.....
New Orleans	13.00	13.00	15.00	60.00	75.00
Birmingham	14.50	14.50	14.50	40.00	45 00
Philadelphia	18 00	18.00	18.00	40.00	50 00
Pittsburgh (del.)	17.00	17.00	16.00	.....	.....
Cleveland	14@ 16	14@16	12@14	.....	.....

* By truck. † In cars. ‡ Imported.

HOLLOW TILE—Price per block in carload lots, f.o.b., to contractors, for hollow building tile.

	New York: Oct. 6 on Trucks*†	One Year Ago	Chicago	Philadelphia	St. Louis	San Francisco†	Perth Amboy N. J., Factory*
4x12x12	$0.1027	$0.1112	$0.076	$0.105	$0.068	$0.108	.....
6x12x12	.1541	.1667	.104	.....	.09	.156	.....
8x12x12	.1926	.2084	.142	.21	.126	.244	.....
10x12x12	.....	.....	.182	.....	.158	.....	$0.2388
12x12x12	.....	.....	.202	.32	.186	.....	.2956

*5 per cent off for cash. †Partition tile.

	4x12x12	8x12x12	12x12x12
Boston	$0.08	$0.14	$0.24
Minneapolis	.072	.125	.225
Cincinnati	.064	.1295	.1726
Kansas City	.088	.158	.242
Denver	.085	.155	.22
Seattle	.10	.18	.26
Los Angeles	.085	.172	.285
New Orleans	.0808	.1516	.2232
Detroit	.0707	.1326	.1853
Montreal	.10	.....	.....
Baltimore	.124	.268	.....
Atlanta	.0724	.1358	.....
Dallas	.103	.19	.31
Birmingham	.11	.124	.255
Pittsburgh	.068	128	.179
Cleveland	.071	.12	.....

STRUCTURAL MATERIAL—Following are base prices per 100 lb. in carload lots, f.o.b. mill, Pittsburgh and Birmingham. At other cities listed, quotations apply on less-than-carload lots from warehouses:

	Pittsburgh	Birmingham	Warehouse: New York	Dallas	St. Louis	Chicago	San Francisco
Beams, 3 to 15 in.	$1.75@ $1.85	$2.05	$3.34	*4.00*	$3.25	$3.10	*3.00*
Channels, 3 to 15 in.	1.75@ 1.85	2.05	3.34	*4.00*	3.25	3.10	*3.00*
Angles, 3 to 6 in., ¼ in. thick	1.75@ 1.85	2.05	3.34	*4.00*	3.25	3.10	*3.00*
Tees, 3 in. and larger	1.75@ 1.85	2.05	3.34	*4.00*	3.35	3.10	*3.00*
Plates, ¼ in. thick and heavier	1.75@ 1.85	1.95	3.34	*4.00*	3.25	3.10	*3.00*

RIVETS—The following quotations are per 100 lb.:

ROUND-HEAD STRUCTURAL

	Pittsburgh Mill	Warehouse: New York—Oct. 6	New York—One Yr. Ago	Chicago	St. Louis	San Francisco	Dallas
½ in.	$2.75@ $3.00	$5.00	$4.20	$3.60	$3.75	$5.50	$4.75
CONE-HEAD BOILER							
½ in.	*$3.00*	$5.00	$4.40	$3.60	$3.90	$5.50	$5.00
⅝ and ¾	*3.15@ 3.25*	5.15	4.55	3.70	3.90@ 4.15	5.65	5.15
⅞ and 1	*3.40*	5.40	4.80	3.95	4.10	5.85	5.50

NAILS—The following quotations are per 100 lb. keg from warehouse:

	Pittsburgh Mill	Birmingham	Chicago	San Francisco	Dallas	St. Louis	Montreal
Wire	$2.55	$2.85	$2.95	$3.25	$4.25	$2.83	$4.95
Cut	2.80	2.90	.....	5.00	5.00	2.95	5.00

SHIP SPIKES—Current prices per 100 lb.:

In.	San Francisco: Galv.	Black	Seattle Black
½	$7.50	$5.75	$7.75
⅝	7.05	5.30	5.65
¾	6.90	5.15	5.50

Pittsburgh base in lots of 200 kegs or more, *$3.10*.

PREPARED ROOFINGS—Slate-surfaced roofing in rolls weighing 85 to 90 lb. costs $1.93½ per square to contractors in carload lots f.o.b. New York.

Single shingles, slate finish, cost $5.62½ per square (sufficient to cover 100 sq.ft.) in carload lots, f.o.b. New York. Strip shingles (4 in 1) f.o.b. New York, in carload lots to contractors, $4.27½ per square for the hexagonal shape, with Underwriters' label.

ROOFING MATERIALS—Prices f.o.b. New York, to contractors in carload lots:

Tarred felt per 100 lb	$2.94½
Asphalt coating, per gal	.31½
Asphalt felt, per 100 lb	3.09

WINDOW GLASS—United inches, 25, bracket size 6x8 to 10x15, single thickness "AA," 83 per cent; "A," 88 per cent; "B," 89 per cent. Double thickness "AA," 83 per cent; "A," 88 per cent; "B," 89 per cent discount from jobbers list at New York warehouses.

SHEETS—Quotations are per 100 lb. in various cities from warehouse also the base quotations at mill:

Blue Annealed	Pittsburgh Large Mill Lots	St. Louis	Chicago	San Francisco	New York
No. 10	$2.25	$3.60	$3.50	*$3.75*	$3.89
No. 12	2.30	3.65	3.55	*3.80*	3.94
No. 14	2.35	3.70	3.60	*3.85*	3.99
No. 16	2.45	3.80	3.70	*3.95*	4.09
Black					
Nos. 18 to 20	2.80@ 2.90	4.25	3.75	*4.60*	4.00
No. 22	2.95@ 3.05	4.40	3.90	*4.75*	4.15
No. 24	3.00@ 3.10	4.45	3.95	*4.80*	4.20
No. 26	3.10@ 3.20	4.55	4.05	*4.90*	4.30
No. 28	3.35@ 3.45	4.70	4.20	*5.05*	4.45
Galvanized					
No. 10	3.15	4.55	4.10	*4.65*	4.25
Nos. 12 to 14	3.25	4.65	4.20	*4.75*	4.35
No. 16	3.35	4.75	4.30	*4.85*	4.45
No. 18	3.50	4.90	4.45	*5.00*	4.60
No. 20	3.65	5.05	4.60	*5.15*	4.75
No. 22	3.70	5.10	4.65	*5.20*	4.80
No. 24	3 85	5.25	4.80	*5.35*	4 95
No. 26	4.10	5.50	5.05	*5.60*	5.20
No. 28	4.35	5.75	5.30	*5.85*	5.45

For galvanized corrugated sheets add 15c., all gages

LINSEED OIL—These prices are per 7½-lb. gallon for raw oil:

	New York: Oct. 6	One Year Ago	Chicago: Oct. 6	One Year Ago
Raw in barrels (5 bbl. lots)	$0.86½	$0 85½	*$0.78*	$0.88

E. N.-R. Prices of Construction Materials

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b. New York:

	Dry		In Oil	
	Oct. 6	1 Yr. Ago	Oct. 6	1 Yr. Ago
Red	$13.75	$15.25	$15.25	$16.75
White	13.75	15.25	13.75	15.25

Lumber

Prices wholesale, per M. ft. b.m., in carload lots, f.o.b.

San Francisco—Prices of rough Douglas fir No. 1 common, in carload lots to contractors at yards.

	6-8 and 12 Ft.	10-16-18 and 20 Ft.	22 and 24 Ft.	25 to 32 Ft.
3x3 and 4	$26.00	$27.00	$28.00	$31.00
3x6 and 8	26.00	27.00	28.00	31.00
4x4-6 and 8	26.00	27.00	28.00	31.00
3x10 and 12	26.00	27.00	28.00	31.00
3x14	30.00	30.00	32.00	34.00
4x10 and 12	26.00	27.00	28.00	31.00
4x14	30.00	30.00	32.00	34.00

	24 Ft. and Under	25 to 32 Ft.	33 to 40 Ft.
6x10	$28.00	$30.00	$32.00
6x14	34.00	36.00	38.00
8x10	28.00	30.00	32.00
8x14	34.00	36.00	38.00

New York and Chicago—Wholesale prices to dealers:

	New York				Chicago	
	20 Ft. and Under L.L.Y.P.		22-24 Ft. L.L.Y.P.		20 Ft. and Under No. 1 L.L.Y.P.	Up to 32 Ft. No. 1 Douglas Fir
3x4 to 8x8	$43.00@$46.00		$44.00@47.00		$38.00	**$39.50**
3x10 to 10x10	50.00	53.00	51.00	54.00	45.00	**39.50**
3x12 to 12x12	57.00	60.00	58.00	61.00	54.00	**39.50**
3x14 to 14x14	65.00	68.00	66.00	69.00	...	**39.50**
3x16 to 16x16	77.00	80.00	78.00	81.00	...	**40.50**

New York—Prices are for long-leaf yellow pine timbers (rough) to dealers, alongside dock. Price to contractors, delivered by trucks from lighters to job, $5@$10 additional. Short leaf pine costs $3 per M. ft. less.

Over 24 ft.—Add $1 for each additional 2 ft. in length up to 32 ft. and $1 for each additional foot from 32 to 36 ft.

Other Cities—On cars or at dock:

	8x8-In. x 20 Ft. and Under				12x12-In. 20 Ft. and Under	
	P.	Fir*	Hemlock	Spruce	P.	Fir*
Boston	$47.75	$47.50	$49.00	$52.00	$57.25	$57.00
Seattle	...	24.00	...	...	...	**24.00**
New Orleans	**45.00**	...	...	...	**50.00**	...
Baltimore	35.00	49.25	53.00	60.00	...	49.75
Cincinnati	**50.00**	...	...	...	**65.00**	...
Montreal	**55.00**	...	...	...	60.00	50.00
Los Angeles	...	32.00	...	...	...	32.00
Denver	...	33.25	34.25	34.25	...	34.25
Minneapolis	42.50	36.75	34.00	...	47.00	38.75
Atlanta	31.00	...	...	...	34.00	...
Dallas	56.00	...	...	...	56.00	...
Kansas City, Mo.	39.00	39.75	...	...	53.00	39.75
Birmingham	32.00	...	...	...	34.00	...
Philadelphia	48.00	36.00	38.00	45.00	62.00	36.00
Detroit	44.00	41.50	...	...	55.00	41.50
St. Louis	39.00	...	...	...	51.00	...

	1-In. Rough, 10 In. x 16 Ft. and Under			2-In. T. and Gr. 10 In. x 16 Ft.	
	P.	Fir*	Hemlock	P.	Fir*
Boston	$43.25	$43.00	$44.50	$48.25	$48.00
Seattle	...	22.00	...	...	23.50
New Orleans	30.00	46.00	...	28.00	34.00
Baltimore	55.00	44.00	44.00	34.00	49.50
Cincinnati	42.50	...	...	**40.00**	...
Montreal	45.00	55.00	40.00	65.00	50.00
Los Angeles	...	24.50	...	...	36.00
Denver	...	32.75	33.25	...	32.25
Minneapolis	40.50	36.25	34.75	35.50	35.00
Atlanta	22.00	...	...	28.00	...
Dallas	52.25	...	...	56.00	...
Kansas City, Mo.	**50.25**	**42.75**	...	39.75	**35.75**
Birmingham	27.00	...	...	45.00	...
Philadelphia	30.00	36.00	36.00	52.00	36.00
Detroit	40.50	37.00	...	30.50	41.25
St. Louis	38.00	...	...	28.00	...

*Douglas fir.

PILES—Prices per lineal foot, pine piles with bark on, f.o.b. New York:

Diameters	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.14½	$0.18½
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.19	.23½
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.21½	.25½
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.25½	.34
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.27½	.36½
14 in.—2 ft. from butt	5 in.	80 to 89 ft.	.35	.41

Miscellaneous

STEEL SHEETPILING—The following price is base per 100 lb. f.o.b. Pittsburgh, with a comparison of a month and a year ago:

Oct. 6	One Month Ago	One Year Ago
$2.20@$2.25	$2.20@$2.25	$2.25@$2.30

CONCRETE BLOCKS—Standard 8x8x16-in., delivered to job, each:

Denver	$0.22	St. Louis	$0.20
Detroit	.16	Boston	.18@.20
New Orleans	...	Minneapolis	.14*
Brooklyn and Queens	.18@.20	Philadelphia	.18@.20
Pittsburgh	.18		

*F.o.b.

WIRE ROPE—Discounts from list price on regular grades of bright and galvanized are as follows:

	Eastern Territory New York and East of Missouri River
Plow steel round strand rope	35%
Special steel round strand rope	30%
Cast steel round strand rope	20%
Round strand iron and iron tiller	5%
Galvanized steel rigging and guy rope	7½%
Galvanized iron rigging and guy rope	+12½%

California, Oregon, Nevada and Washington: Discount 5 points less than discount for Eastern territory.

Wyoming, New Mexico and Colorado: Discount 5 points less than discount for Eastern territory.

Arizona: Discount 10 points less than discount for Eastern territory.

Montana, Idaho and Utah: Discount 10 points less than discount for Eastern territory.

North Dakota, Nebraska, Kansas, Oklahoma and Texas: Discount 5 points less than discount for Eastern territory.

MANILA ROPE—For rope smaller than ¾-in. the price is ½ to 2c. extra; while for quantities amounting to less than 600 ft., there is an extra charge of 1c. The number of feet per pound for the various sizes is as follows: ¼-in., 8 ft.; ⅜-in., 6; ½-in., 4½; ⅝-in., 3½; ¾-in., 2 ft. 10 in.; 1-in., 2 ft. 4 in. Following are prices per pound for ¾-in. and larger, in 1200-ft. coils:

Boston	**$0.245**	New Orleans	$0.21
New York	.25	Los Angeles	.25
Chicago	**.23½**	Seattle	.23
Minneapolis	**.25½**	St. Louis	.22½
San Francisco	.22½	Montreal	.17
Atlanta	.27	Detroit	.24½
Denver	**.25½@.26½**	Baltimore	.18
Cincinnati	.21	Kansas City	**.25½**
Dallas	.31	Birmingham	.26@.27
Philadelphia	.24		

EXPLOSIVES—Price per pound of dynamite in small lots:

	Gelatin 40%	Gelatin 60%
New York	$0.265*	$0.2875*
Boston	.235	.265
Kansas City	.205	.225
Seattle	.165	.19
Chicago	.195†	.2175†
Minneapolis	.1917	.2123
St. Louis	.22	.24½
Denver	.2025	.2275
Dallas	.225	.306
Los Angeles	.1875	.2225
Atlanta	.23	.255
Baltimore	.22	.23
Cincinnati	.22	.245
Montreal	.1675	.1895
Birmingham	.22	.24
New Orleans	.235	.26
San Francisco	.1625	.1925
Philadelphia	.215	.24

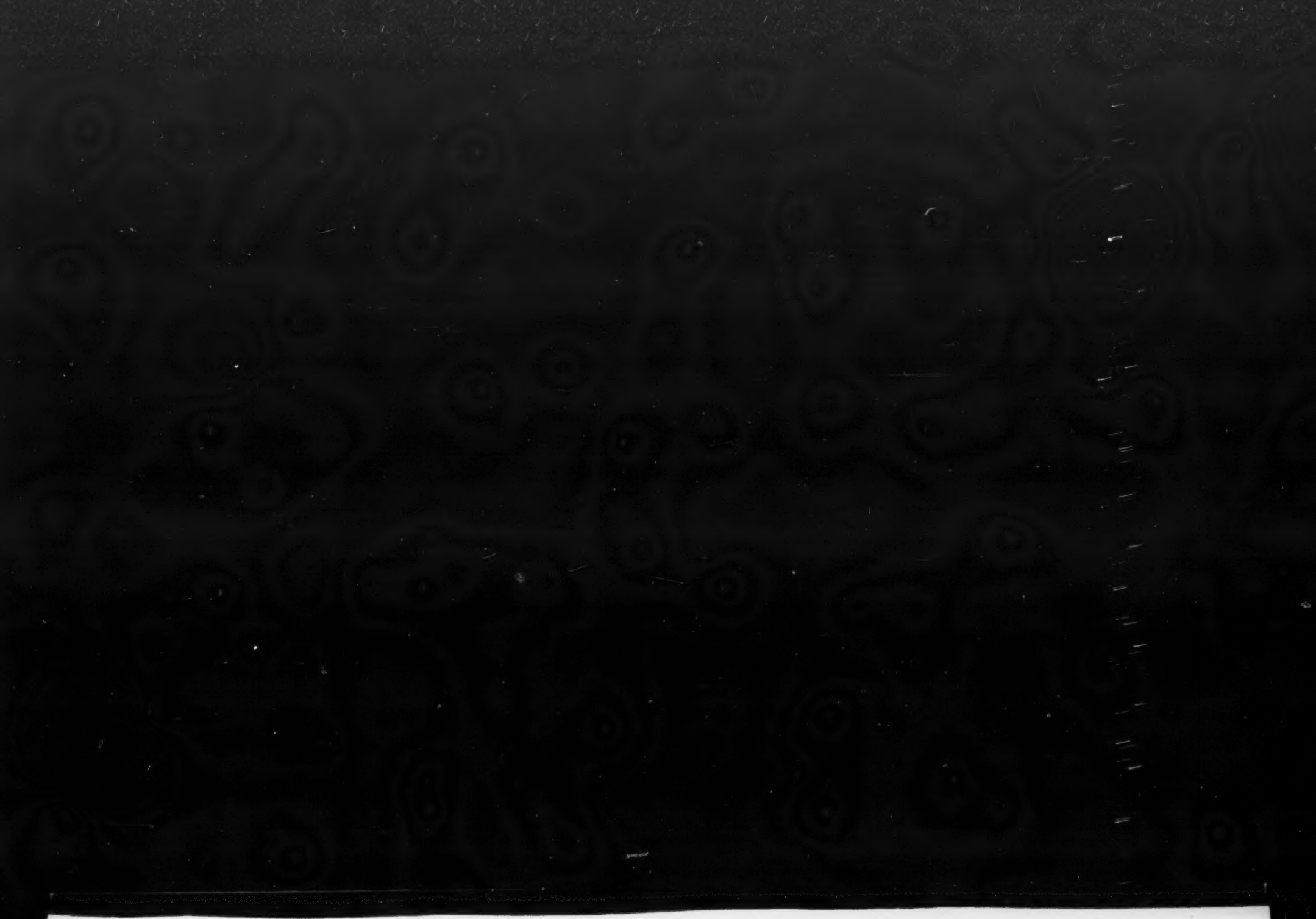
*Special gelatin in case lots. †Quantities above 500 lb. and less than a ton

CHEMICALS—Water and sewage treatment chemicals, round lots at New York:

Sulphate of aluminum, in bags, per 100 lb	$2.00@$2.10
Sulphate of copper, in bbl., per 100 lb	5.00@5.10
Soda ash, 58%, in bags, per 100 lb	1.32½@1.37½
Chlorine, liquid, cylinders, per lb	.05½@.08
Hypochlorite of lime (bleaching powder) in drums, per 100 lb	2.00@2.10*

*F. o. b. Works.

FREIGHT RATES—On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant steel, bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carloads of 36,000 lb.:

Atlanta	$0.58	Detroit	$0.29
Baltimore	.31	Kansas City	.735
Birmingham	.58	New Orleans	.67
Boston	.365	New York	.34
Buffalo	.265	Pacific Coast (all rail)	1.15*
Chicago	.34	Philadelphia	.32
Cincinnati	.29	St. Louis	43
Cleveland	.19	St. Paul	.60
Denver	1.15*		

* Minimum carload, 50,000 lb., structural steel only; 80,000 lb., for other iron or steel products.